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ABSTRACT

The study derives a model of the unemployment insurance (UI) system and its relationship to the labor market, estimates it with data from the Detroit Standard Metropolitan Statistical Area, and evaluates its potential use to forecast UI benefit amounts, UI insured unemployment, and UI exhaustions. It further uses the model to analyze policy issues relating to UI and to simulate alternative UI systems which could be created by revising the provisions of the existing UI system. A set of seven recursive equations links the UI policy variables to the variables which represent supply and demand in the labor market, with special attention being given to the specification of the pivotal equations for insured unemployment and UI exhaustions. An analysis of these equations indicates that the chances of a worker finding a job diminish rapidly the longer the worker has been unemployed, and that UI leads to a small increase in the average duration of unemployment, but that the increase has only a small effect on the aggregate unemployment rate. Five alternative UI systems are simulated, each created by revising one of the key provisions of the existing law. The simulations are related to the determination of optimal UI policies. (Author/JR)

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AN ECONOMETRIC ANALYSIS OF THE UNEMPLOYMENT INSURANCE SYSTEM IN A LOCAL URBAN LABOR MARKET

MAY 05 1975

Stephen T. Marston

Institute of Labor and Industrial Relations
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A "labor turnover" view of the labor market is shown to be successful in explaining insured unemployment and UI benefit exhaustions and the process of job acquistion as a function of the duration of unemployment.

Given the tightness of the labor market, the chances of a worker finding a job are found to diminish rapidly the longer the worker has been unemployed, largely due to the heterogeneity of the labor force and human capital depreciation during long unemployment.

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by

Stephen Tilney Marston

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Doctoral Committee:

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ABSTRACT

AN ECONOMETRIC ANALYSIS OF THE UNEMPLOYMENT INSURANCE SYSTEM IN A LOCAL URBAN LABOR MARKET

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Stephen Tilney Marston

Chairman: Saul H. Hymans

This study derives a model of the unemployment insurance (UI) system and its relationship to the labor market, estimates it with data from the Detroit SMSA, and evaluates its potential use to forecast UI benefit amounts, UI insured unemployment and UI exhaustions. It further uses the model to analyze policy issues relating to UI and to simulate alternative UI systems which could be created by revising the provisions of the existing UI system.

A set of seven recursive equations links the UI policy variables to the variables which represent supply and demand in the labor market.

Special attention is given to the specification of the pivotal equations for insured unemployment and UI exhaustions. In these equations the model goes behind the stock of unemployed workers to study the transitions of workers to and from employment and in and out of the UI system. This "labor turnover" view of the labor market is shown to

be successful in explaining insured unemployment and UI benefit exhaustions and also to describe the process of job acquisition as a function of the duration of unemployment.

The above two equations represent a new econometric application which can be used to model and analyze a class of stock-flow processes which occur frequently in economics. The method is applicable when it is necessary to specify the stock of individuals in some state as a function of the rate of flow of individuals into the state, and it is further known that the rate of flow of individuals in and out of the state is non-stationary. In the particular example, the stock of insured unemployed workers is specified as a function of the number of UI covered workers losing their jobs, and the probability of a worker becoming re-employed depends on the tightness of the labor market and the duration of the worker's unemployment. This approach is contrasted with the simple Markov chain where the transition probabilities are assumed constant.

The labor market transition rates which fall out of this analysis are examined for their implications about job search. The chances of a worker finding a job are found to diminish rapidly the longer the worker has been unemployed. Part of this is explained by the heterogeneity of the labor force and part of it by human capital depreciation during long unemployment.

The incentive effect of UI in job search is the subject of an independent application of the estimated labor market transition rates. The issue studied is whether UI subsidizes unemployed workers to remain unemployed longer than they would in the absence of UI. Re-employment rates are compared between insured and uninsured unemployed workers. It is concluded that UI leads to a small increase in the average duration of unemployment, but the difference is found to cause only a small increase in the aggregate unemployment rate.

Five alternative UI systems are simulated. Each is created by revising one of the key provisions of the existing law. The provisions thus studied are the coverage of the UI system, the duration and existence of a waiting period before benefits can be collected, the rule for determining potential durations, and the maximum length of potential durations. The simulations are related to the determination of optimal UI policies.

To Peggy

9

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CHAPTER I

INTRODUCTION

1.1 The Unemployment Insurance System

The central and by far the most important support for unemployed workers in America is the unemployment insurance (UI) system. Established in 1935 UI paid out $3.8 billion in benefits to six million people in 1970 (U.S. Dept. of Labor 1971). As in any insurance program this support is paid as a right of the insured worker; it does not require a humiliating demonstration of poverty. Neither does a jury sit in judgment of this compensation; only a routine administrative decision is usually necessary to secure payments. The fundamental decisions are left to economic forces: the ebb and flow of employment, the distribution of employment among firms and individuals and the level of wages. These factors determine UI benefit payments, on the one hand, and UI employer contributions, on the other.

These forces and variables have not previously been woven into a consistent and meaningful pattern. As a consequence there is a substantial degree of uncertainty as to the operation of the UI system and as to the magnitude of UI activities to be expected in the future. The objective of this model is to provide forecasts of the levels of UI

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variables and to investigate the causal relationships which connect supply and demand in the labor market with the income-support activity of the UI system. The derived relationships are applied to study alternative UI systems and to evaluate the work incentive effects of the existing UI system and proposed alternatives to the existing UI system.

The Detroit experience is used as the empirical example. Specifically three quantities are projected for the Detroit standard metropolitan statistical area (SMSA):

1. The Total Cost of UI Benefits - The amount of compensation paid out during a future time period.
2. Insured Unemployment - The number of individuals reporting a week of unemployment under the UI program.
3. UI Benefit Exhaustions - The number of people who will receive their final UI payment and become ineligible for further compensation.

1.2 State UI Policy Guidance

Each of the above quantities is useful in forming state policies and laws in the UI area. UI benefit payments are drawn out of state funds contributed by employers for UI purposes. The fund must maintain a positive balance, yet it must not be allowed to grow unnecessarily large. In the long run optimal employer contribution rates should be designed to minimize the excess of employer contributions over UI payments, subject to the constraint that the fund must retain a positive balance at all times. These optimal employer contribution rates can be calculated with reference to accurate long-run projections of future UI payments. Optimal employer contribution rates would minimize the economic distortion caused by compulsory employer contributions. In the long run optimal employer contribution rates should be one of the goals of state UI legislation.

In the short run accumulated UI fund balances should be used as productively as possible. State UI fund balances should be used as productively as possible. State UI fund balances are deposited with the U.S. Treasury where they earn a substantial return. The goal of month-to-month state policy should be to requisition only the minimum funds from that account necessary to meet future UI expenditures. Any larger requisition results in the waste of earnings which would otherwise accrue in the U.S. Treasury account. Estimation of the minimum requisition requires a short-run projection of UI expenditures. Accurate projections could possibly save the states large sums annually in foregone earnings. Thus projections of UI benefit payments can help guide state planning-programming-budgeting in both the long run and the short run.

The number of insured unemployed workers is equal to the number of continued UI claims made and will be an indicator of the activity to be expected in the Employment Security branch offices. It will also be useful to compare the insured unemployment with total unemployment to get a view of the adequacy of the UI system. Also useful in this view is the number of benefit exhaustions. When people exhaust their UI benefits they are forced to provide income for themselves in other ways. Hence they may become welfare burdens or require other expenditures of the state.

In addition to providing forecasts of the three useful quantities mentioned above, this model will provide answers to critical questions about the UI system itself, particularly regarding the costs and benefits of proposed alterations to the UI system. For example, the model could predict the impact of an increase in the maximum duration of UI benefits from say 26 to 39 weeks on the number of insured unemployed, the cost of UI payments, and the decrease in the number of benefit exhaustions for Detroit. This question can be asked for any reasonable increase or decrease in the maximum duration of benefits, and the model will provide estimates of the number of insured unemployed, amount of payments and exhaustions that will result.

Other types of questions which can be answered by this model are the effect upon insured unemployment, payments and exhaustions of increases in the industrial coverage of the Michigan UI system, alterations in the rules for making monetary determinations for new UI claimants, or changes in the average amount of payments. The model will simulate the proposed UI system and generate forecasts of these variables for the new system. The forecasts will be useful to lawmakers in estimating the costs of their proposals and in judging whether the UI system they propose will achieve the income security they seek.

In view of the frequency with which the Michigan legislature revises the provisions of its UI law, it is necessary to have a flexible model for UI forecasting. The Michigan UI system is an income maintenance plan which is dynamic and evolving. This is not an environment which gives credence to the usual ceteris paribus assumptions about administrative procedures. Every time the UI law is amended (three times in the last three years) the relationship among UI variables is changed and the model must be adjusted if it is to give accurate forecasts. The present model allows incorporation of these amendments without re-estimation of the parameters.

1.3 Manpower Issues

The Insured Unemployment equation of this model focuses on the process by which insured unemployed workers find their way back to employment. In so doing it illuminates some issues relating to the duration of unemployment: How does an individual's chance of finding employment depend upon the length of time he has been unemployed? How does his chance of finding employment depend upon the "tightness" of the labor market? To what extent might an individual's chance of becoming employed be influenced by the payment of UI benefits? These issues are addressed and some hypotheses are advanced.

One of these issues is singled out for special consideration because of its far-reaching importance for the UI system and for a stabilization policy. The issue is whether the UI system subsidizes unemployment and therefore provides an incentive for workers to remain unemployed longer than they would otherwise. This is a controversial issue and not one which can be resolved within the narrow goals of this study; however, a new approach is described and some tentative conclusions are stated.

The method of dealing with these issues is a probabilistic time analysis introduced recently by economists studying "labor turnover" (Kaitz 1970, Perry 1972, Hall 1972). Labor turnover has received increasing attention among economists because of a desire to look beyond the stock nature of employment and unemployment and examine the important flows between employment, unemployment and leaving the labor force. It is, for instance, of critical importance whether a given level of unemployment consists of a large number of people who remain unemployed only briefly, or, alternatively, by fewer people who remain unemployed much longer. What data exist suggest that the United States is characterized by rapid labor turnover, rather than by a large, stagnant unemployment pool. It is also important whether the high unemployment of a particular socio-economic group is due to short job tenure or long unemployment duration. The appropriate remedy for unemployment will depend very much upon the answers to these questions.

1.4 Applicability of the Model to Other Areas

While the model has been developed for Detroit, it is equally applicable to the entire state of Michigan. This would involve reestimating the equations using state data. The model should be thought of as a prototype for similar models which could be developed for all states. Models for other states will differ from the one for Michigan, but will retain the same basic structure. This is, of course, the great advantage of state or SMSA-level UI models: their scope is no larger than the UI systems themselves.

The model can be applied to a wide range of different UI policy issues in a wide range of different geographical areas. It is hoped it can provide a basis for scientific program evaluation in the future.

CHAPTER II

AN OVERVIEW OF THE UI MODEL

2.1 The Variables and Data

Figure 2.1 lays out the provisions of the Michigan UI law in diagrammatic form. The system is similar to that of the other states. A recently laid off worker who is covered by UI may make an initial claim and receive a determination of the number of weeks, if any, for which he is eligible to collect UI benefits. After a one week waiting period he is eligible for payments by making a continued claim each week. If the person is unemployed longer than his determination, he may receive extended benefits or become an exhaustee. During this process he may delay filing his initial claim, be disqualified, become employed or leave the labor force.

Figure 2.1 is too detailed to be used directly to generate an estimable UI model. Figure 2.2 has been drawn to simplify the UI system, leaving out administrative minutae and concentrating on the main flows.

Each of the categories represented by a box in Figure 2.2 corresponds to a variable in the model. Each variable represents the number of people in that category. Each of the

Figure 2.1 Flow Chart For Unemployment Insurance Claims

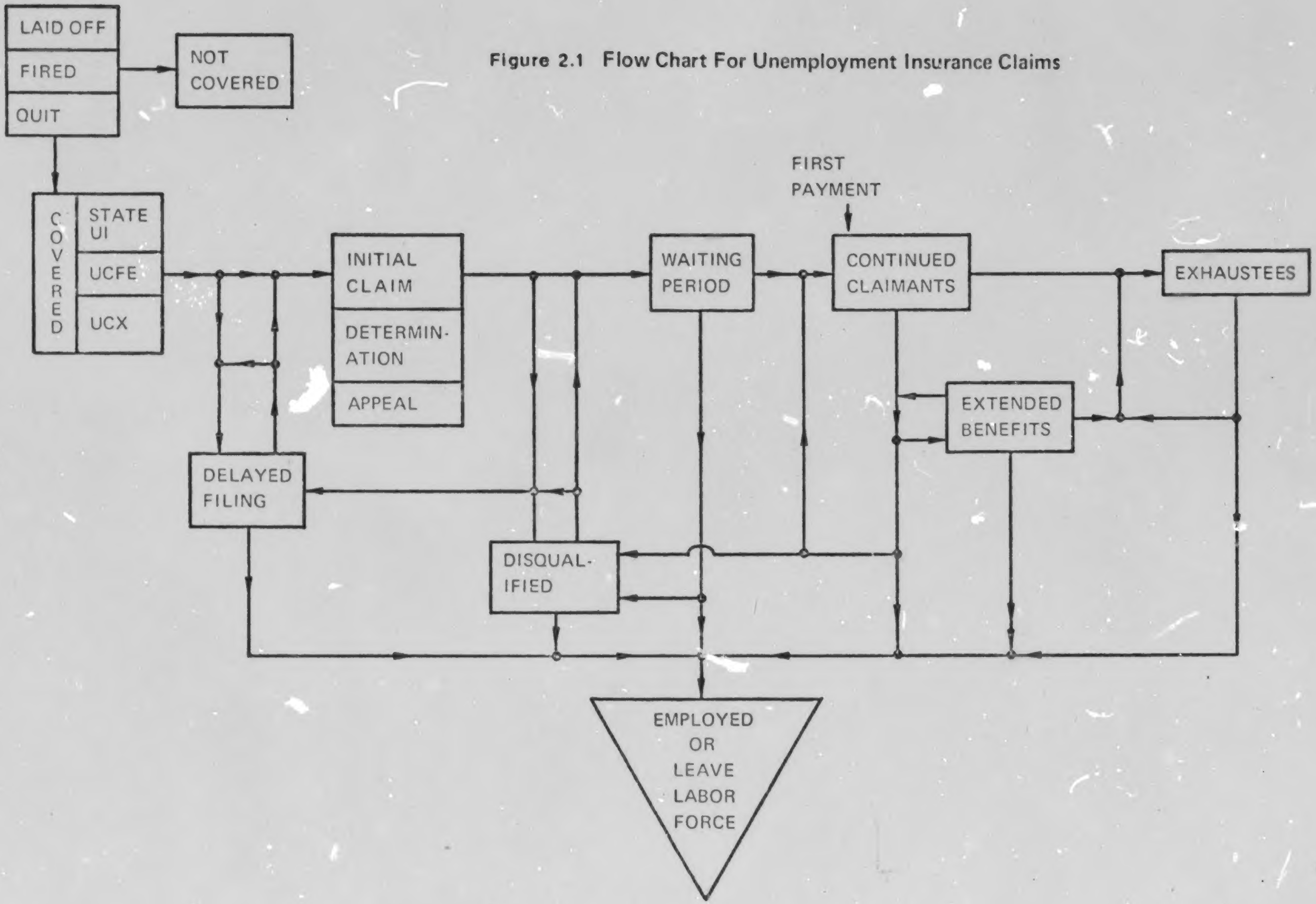
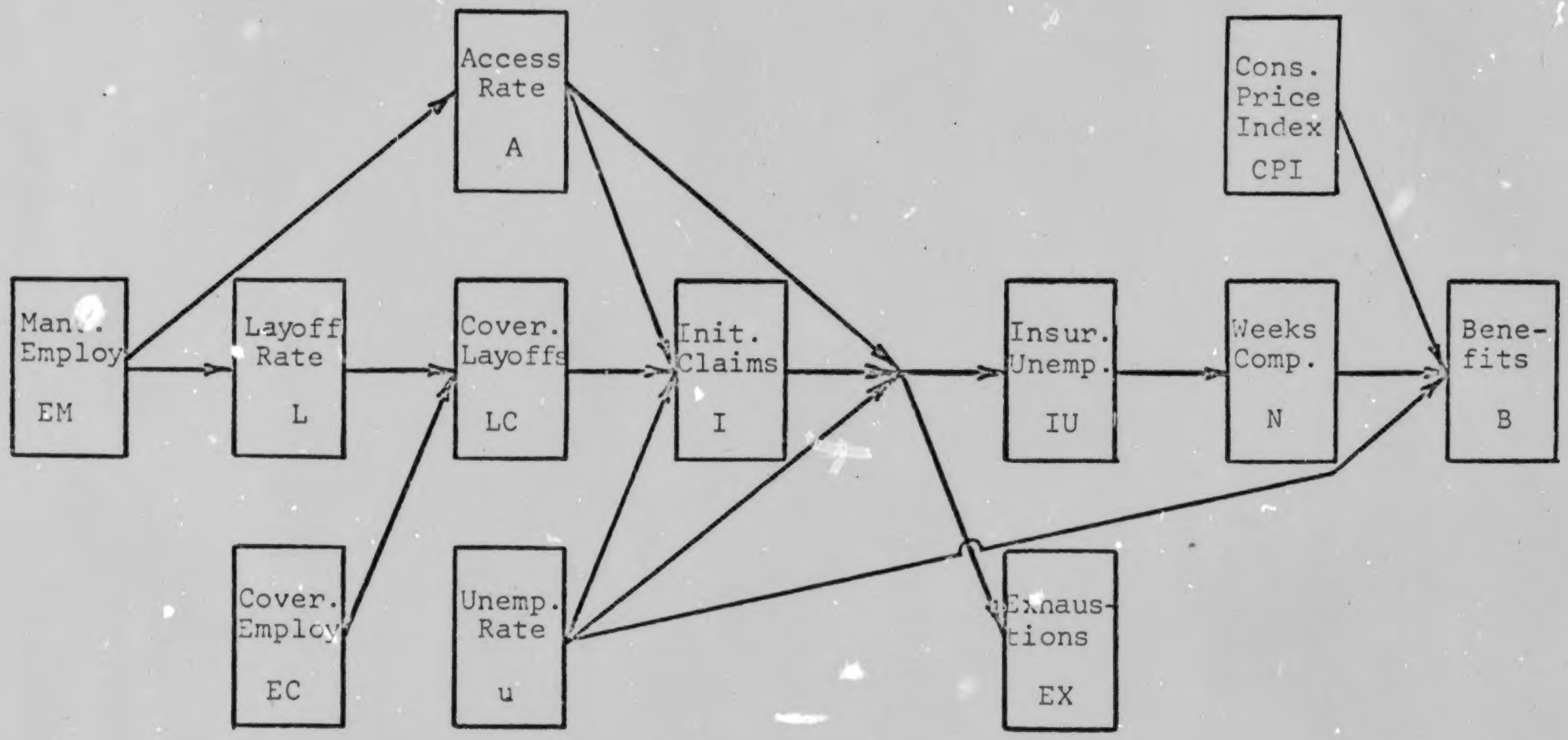

LAID OFF
FIRED
QUIT
NOT COVERED
COVERED
STATE UI
UCFE
UCX
INITIAL CLAIM
DETERMINATION
APPEAL
DELAYED FILING
DISQUALIFIED
WAITING PERIOD
FIRST PAYMENT
CONTINUED CLAIMANTS
EXTENDED BENEFITS
EXHAUSTEES
EMPLOYED OR LEAVE LABOR FORCE

Figure 2.2 Flow Chart For Unemployment Insurance Variables and Equations


Manf. Employ EM
Layoff Rate L
Cover. Employ EC
Access Rate A
Cover. Layoffs LC
Unemp. Rate u
Init. Claims I
Insur. Unemp. IU
Exhaus- tions EX
Cons. Price Index CPI
Weeks Comp. N
Bene- fits B

arrows represents a transition from one category to another and generally requires the passage of time. So the model can be viewed as a stochastic chain relating the number of people in each category intertemporally.

This form of the model is desirable for three reasons:

1) The Michigan UI laws and worker behavior determine the relations in an understandable way.
2) The data available at Michigan Employment Security Commission (MESC) correspond to the categories it defines.
3) It leads to a model which is related closely enough to the UI laws that changes in those laws can be introduced and their effects deduced.

2.2 An Overview of the Model

The cost of UI benefits (B) is closely related to the number of insured unemployed workers (IU). This cost in dollars can be found by multiplying the number of weeks compensated (N) by the average amount of one payment. The number of weeks compensated is slightly less than the number of insured unemployed (some of the insured weeks are not compensable because they are waiting weeks or disqualified weeks) and the average payment is primarily a function of recent wages. These simple relationships define two econometric equations, the first of which gives benefit costs as a function of the number of weeks compensated and the second of which gives the number of weeks compensated as a function of insured unemployment.

The size of insured unemployment has long been considered a difficult quantity to forecast and the forecasting problems that exist are more severe on the state or SMSA level than they are on the national level. One difficulty is that the SMSA unemployment rate may not be used as a driving variable to determine SMSA insured unemployment, although the national unemployment rate is used by the UI Service to predict the number of recipients of federal unemployment compensation programs. This is due to the origin of state unemployment data: on the state and SMSA levels, the number of total unemployed (and, thus, the unemployment rate) is calculated originally from the number of insured unemployed.* The Current Population Survey (CPS), which gives national unemployment rates, though available for metropolitan areas, is not commonly reported and used. This leaves the labor market analyst with an unemployment figure which has been derived from the insured unemployment figure and should not be used to re-calculate the insured unemployment figure. This would amount to calculating A from B and B from A without obtaining any net improvement in information. The state unemployment figures are quite useful generally, but not for direct use in a UI model.

---

*The so-called "70-step procedure" (U.S. Dept. of Labor 1960). The method is being revised substantially starting in 1974 to place more reliance on CPS estimates of unemployment for large metropolitan areas. Still the monthly changes in unemployment, even for large SMSA's, are derived from administrative insured unemployment figures. See Wetzel and Ziegler (1974).

Even if an independent unemployment estimate were available (such as from the CPS) there would be problems with using it to predict insured unemployment. The insured unemployed are primarily "job losers," whereas total unemployment includes "job leavers" and "new entrants and reentrants to the labor force." This is because new entrants to the labor force are not covered under existing Michigan UI laws and job leavers must endure a substantial disqualification period before receiving benefits. Reentrants are mostly uncovered. The relative size of the four aggregates changes over the course of the business cycle, leading to an observed phenomenon where the insured unemployment rate rises relative to the unemployment rate in the beginning of an economic downturn and reverses itself during the upswing (Green 1971).

These predictions, therefore, are based upon the layoff rates from the Job Openings and Labor Turnover Sample (JOLTS). Two equations are used: (1) The first equation predicts the number of initial UI claims from the number of layoffs. The difference between the two results from layoffs in non-covered industries and laid-off workers who delay filing or do not file for UI. (2) The second equation predicts the number of insured unemployed from the number of initial claims. This is done by using a system of "continuation rates" (analogous to survival rates in population models) to predict the number of people receiving UI from the number who made initial claims in previous months. The two equations work together to predict insured unemployment from layoffs.

A final equation predicts benefit exhaustions (EX) from initial claims using a similar "continuation rate" method to predict the number of initial claimants from previous months who are still unemployed at the end of their maximum benefit duration.

2.3 List of Variables and Equations

This model includes nine primary variables and two secondary variables. The primary variables influence each other directly, while the secondary variables influence the operation of the model indirectly by modifying the relationship among the primary variables.

1) Primary Variables

   A. Manufacturing Employment (EM)
   B. UI Covered Employment (EC)
   C. Layoff Rate (L)
   D. Initial Claims (I)
   E. Insured Unemployment (IU)
   F. Exhaustions (EX)
   G. Number of Weeks Compensated (N)
   H. Amount of Benefit Payments (B)
   I. Consumer Price Index (CPI)

2) Secondary Variables

A. Unemployment Rate (u)

B. Rate of Accessions in Manufacturing (A)

One more variable is defined within the model itself:

Covered Layoffs (LC)

The equation system can be used in two different configurations, the first configuration has five exogenous variables: the layoff rate (L), the accession rate (A), the unemployment rate (u), covered employment (EC) and the Consumer Price Index (CPI). The second configuration is the same, except that the layoff rate and the accession rate are forecasted from the exogenous variable manufacturing employment (EM). Each of the other five variables has an equation to forecast it. Minor variables are defined for temporary purposes in situations where they are required. The letters a and b are used repeatedly to represent equation parameters.

There are seven equations in the model. The equations are named according to the name of the dependent variable of the equation.

3) Equations

A. Layoff Rate

B. Accession Rate

C. Initial Claims

D. Insured Unemployment

E. Exhaustions

F. Number of Weeks Compensated

G. Amount of Benefit Payments

The insured unemployment equation and the exhaustions equation are similar in that they both use a non-stationary Markov specification and a non-linear method of estimation. These similarities make it convenient to treat them together in Chapters III and IV. The other equations are similar in that they are all specified in a more traditional linear regression framework. Their specification appears in Chapter V.

CHAPTER III

TWO NON-LINEAR, NON-STATIONARY MARKOV PROCESSES: INSURED UNEMPLOYMENT, EXHAUSTIONS

3.1 Definition of Insured Unemployment

Continued claims are filed by covered unemployed workers who have previously filed an initial claim and are returning to collect UI benefits in subsequent weeks. The number of continued claims during a time period is defined as insured unemployment.* Initial claims in previous periods generate continued claims in the current period and continued claims, in turn, generate UI benefit payments (also in the current period). Thus the number of continued claims during a time period forms a very useful intermediate variable between initial claims and UI payments.

3.2 Determinants of Insured Unemployment

Insured Unemployment during any month or week will be a function of:

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*In administrative data continued claims are allocated to the week in which they were filed. However, they cover insured unemployment of the preceding week. Hence, there is an accounting problem in adjusting the timing of claims to that of insured unemployment. Also, in some jurisdictions there may be bi-weekly claims taking, which requires further adjustment. See Appendix F for data transformation to eliminate both problems.

1) The number of initial claims in previous periods. (As recently as the previous week and as far back as 26 weeks earlier.) The higher the number of initial claims in previous periods the higher the number of people who can potentially make continued claims in the current period.

2) The "tightness" of the labor market. The more workers who are able to find jobs during previous periods, the fewer of them who will require UI in the current period and will make a continued claim to apply for it. The present model expresses the unemployed worker's ability to find work during any period in the "continuation rate": the probability of remaining unemployed during the current period. This is equal to unity minus the probability of finding employment or dropping out of the labor force.

The probability of finding employment for a particular cohort of people is postulated to be a function of (a) how long the cohort has been unemployed already and (b) the excess demand for labor services. Hyman Kaitz (1970) has shown that the longer a person has been unemployed the less likely he is to find a job by the end of the current period. The higher is labor demand the more likely a particular individual is to be hired, *ceteris paribus*.

3) The potential duration of payments assigned to UI applicants in previous periods. The longer the potential duration given, the longer the time during which applicants will be eligible for UI and the more initial claimants will still be making continued claims during the current period,

because people who made initial claims in earlier time periods will still be eligible to make continued claims. This will mean that longer potential durations will result in more continued claims during the current period.

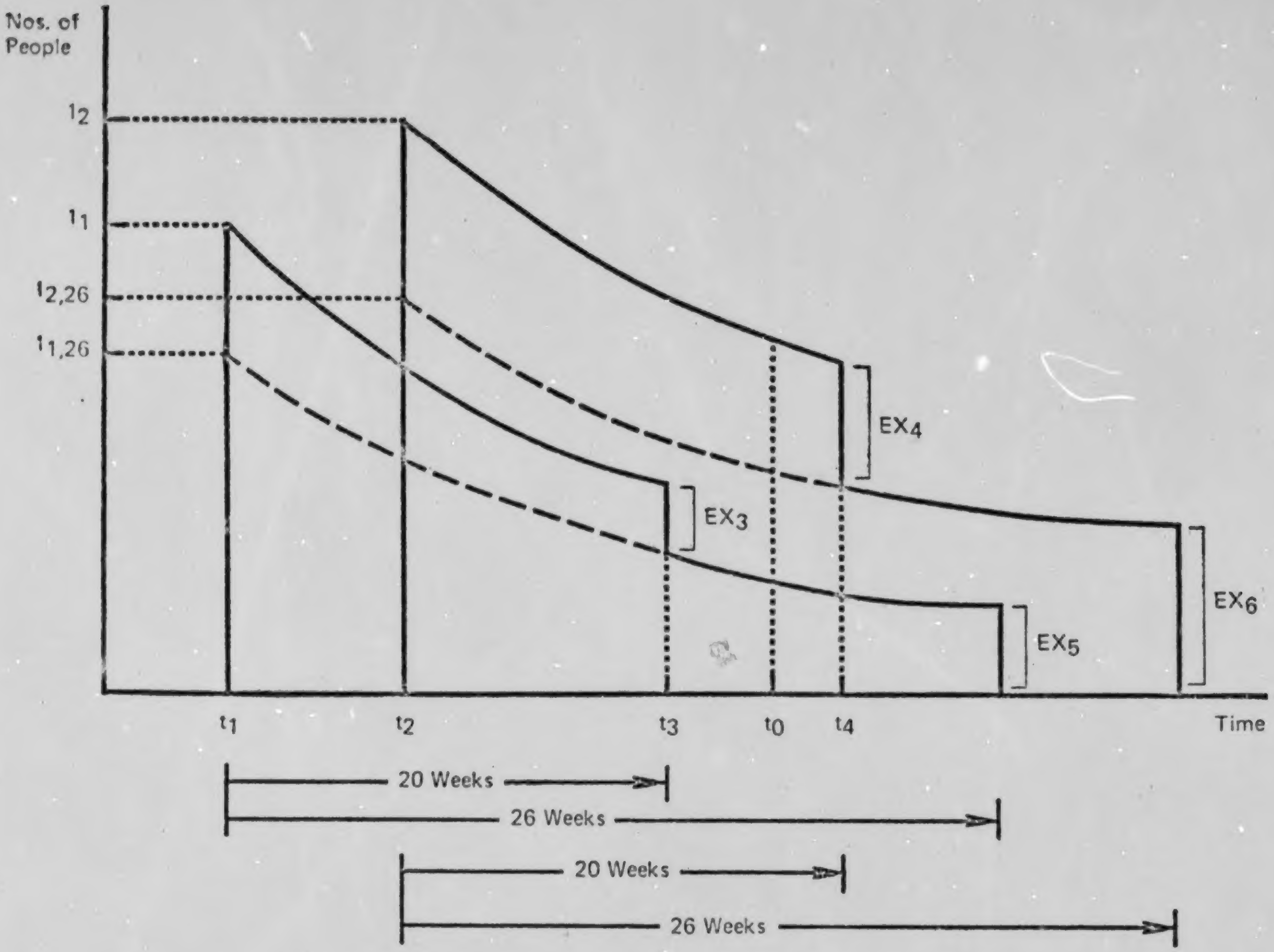
3.3 Graphical Presentation

These simple relations lead to a very interesting time dependence. Before trying to grapple with it mathematically it is useful to study a simple picture of the process.

Suppose (in Figure 3.1) I_1 people file initial claims in week t_1; $I_{1,26}$ of them are eligible for 26 weeks of benefits and $I_{1,20} = I_1 - I_{1,26}$ are eligible for 20 weeks. As time passes the number of continued claimants declines until week t_3 when EX_3 people who were only eligible for 20 weeks exhaust these benefits. After this week only the people who were eligible for 26 weeks of payments survive and decline in number. Similarly for the I_2 people filing initial claims in week t_2. At a particular week t_0 the number of continued claimants is equal to the number of claimants remaining from $I_{1,26}$ plus the number of claimants remaining from I_2. This means the graphs may be added vertically to calculate the total number of continued claims in any period.

The slope of the curved lines changes as the continuation rate changes. The slope of these lines expresses how many of the UI claimants "survive" into the next period. If the continuation rate is one the curve will be horizontal and the slope will be zero, depicting the situation where no

Figure 3.1 Insured Unemployment



one is leaving the UI system to accept employment, and continued claims are constant between time periods. Conversely, if every UI claimant returned to work during one week the curve would decline almost vertically and the slope would become very negative. In all cases the slope will be between these two extremes and will always be negative. The present model allows this slope to change in every period depending upon the length of time since initial claim (for example $t_0 - t_1$, for the group which entered in period t_1, assuming t_0 is the current period) and the level of labor demand. For any particular period, say t_0, the slope will differ for the group which entered in t_1 as compared with the slope for the group which entered in t_2 because aggregate labor demand is the same (since we are looking at a single time period) and the length of time since initial claim is different. The first group will always have a "flatter" (less negative) slope at t_0 because its members have been unemployed longer and therefore are less likely to find a job during the current period.

3.4 Definitions

Let

$X_{t,p,k}$ = the number of people making a continued claim in week t who filed their initial claims in week p and who are eligible for k weeks of payments (k = potential duration of benefits).

$I_{p,k}$ = the number of people receiving first payments in week p and eligible for k weeks of benefits.

IU_{tk} = the number of people making a continued claim in week t and who are eligible for k weeks of payments.

IU_t = the number of people filing continued claims in week t; $IU_t = \sum_k IU_{tk}$ = Insured unemployment in week t.

Consider $X_{t,t-i,k}$, the number of people making a continued claim in week t who filed their initial claims i weeks previous to t and who are eligible for k weeks of payments. Compare this number of people with $X_{t-1,t-i,k}$, the number of people in the same cohort of insured unemployed (same initial claim date and same duration), but counted in the previous week, t-1, rather than t. During the time between week t-1 and week t some of the UI claimants of week t-1 will find jobs, leave the labor force or be disqualified and therefore will not make a claim in week t. However, it is not possible for any new claimants to enter in week t; this is because we are restricting our view to a single cohort who entered in week t-i. Therefore $X_{t-1,t-i,k}$ will necessarily be greater than or equal to $X_{t,t-i,k}$.

Let us define a continuation rate, r, which will be the fraction of UI claimants from a particular cohort who "survive" into the next week. Then

$$X_{t,t-i,k} = rX_{t-1,t-i,k} \qquad (3.1)$$

$0 \leq r \leq 1$.

r will certainly not be a constant. It may be different in different weeks t, for different lengths of time i since initial claim, or for different durations k.. For complete generality, then,

$$X_{t,t-i,k} = r_{t,i,k} X_{t-1,t-i,k} \tag{3.2}$$

where the subscripts on r indicate indices which may be relevant to the value of r. Similarly, for the previous week,

$$X_{t-1,t-i,k} = r_{t-1,i,k} X_{t-2,t-i,k} \tag{3.3}$$

Substituting (3.3) into (3.4)

$$X_{t,t-i,k} = r_{t,i,k} r_{t-1,i,k} X_{t-2,t-i,k} \tag{3.4}$$

Repeating this process for i substitutions

$$X_{t,t-i,k} = \left(\prod_{m=0}^{i-1} r_{t-m,i,k}\right) X_{t-i,t-i,k} \tag{3.5}$$

Now

$$I_{t-i,k} = X_{t-i,t-i,k} \tag{3.6}$$

because the number of people making continued claims in week t-i and entering in period t-i is equal to the number of people filing initial claims in period t-i.

Define $$b_{tik} = \prod_{m=0}^{i-1} r_{t-m,i,k} \tag{3.7}$$

b_{tik} can be interpreted as the probability of remaining unemployed for i weeks, since it is the product of the probabilities of remaining unemployed during each of the i intervening weeks.

Substituting (3.6) and (3.7) into (3.5),

$$X_{t,t-i,k} = b_{tik} I_{t-i,k} \tag{3.8}$$

IU_{tk} is equal to the sum of continued claims in period t over all cohorts:

$$IU_{tk} = \sum_{i=0}^{k-1} X_{t,t-i,k} \tag{3.9}$$

or

$$IU_{tk} = \sum_{i=0}^{k-1} b_{tik} I_{t-i,k} \tag{3.10}$$

This equation has a simple interpretation for insured unemployed workers with potential duration of k weeks. b_{tik} is the fraction of such workers unemployed in week t after i weeks of unemployment. Similarly $b_{tik} I_{t-i,k}$ is the number of such workers still unemployed in week t after making initial claims in week t-i. Equation (3.10) merely states that the number of insured unemployed workers can be calculated by adding up the numbers of workers still unemployed from all previous weeks t-i which are recent enough that the workers will not have exhausted their benefits.

3.5 Aggregating Over Potential Duration of Benefits, k

This researcher does not presently have data for Detroit on IU_{tk} or I_{tk}; that is, observations on insured unemployment and initial claims broken down by potential duration (k). Instead he has only the respective sums

$$IU_t = \sum_{k=1}^{K} IU_{tk} \quad \text{and} \quad I_t = \sum_{k=1}^{K} I_{tk} \tag{3.11}$$

where K = maximum potential duration. Only for all of Michigan does LMIS have disaggregate data on initial claims. Therefore the Detroit model must be aggregated over potential duration, k.

$$IU_t = \sum_{k=1}^{K} IU_{tk} = \sum_{k=1}^{K} \sum_{i=0}^{k-1} X_{t,t-i,k}. \tag{3.12}$$

Rearranging the summation,

$$IU_t = \sum_{i=0}^{K-1} \sum_{k=i+1}^{K} X_{t,t-k,k}. \tag{3.13}$$

Substituting for $X_{t,t-i,k}$ from (3.8)

$$IU_t = \sum_{i=0}^{K} \sum_{k=i+1}^{K} b_{tik} I_{t-i,k}. \tag{3.14}$$

Assuming the continuation rates do not depend upon k

$$IU_t = \sum_{i=0}^{K} b_{ti} \sum_{k=i+1}^{K} I_{t-i,k}. \tag{3.15}$$

This equation tells us that the proper independent variables for IU_t are $\sum_{k=i+1}^{K} I_{t-i,k}$ rather than the variables of the existing data set, which are $I_{t-i} = \sum_{k=1}^{K} I_{t-i,k}$. We will be using all of the initial claims (summing over all k) whereas we should use only those initial claims which begin a UI payment schedule long enough to extend payment into the current period (summing from i+1 to K). This misspecification of the equation will cause bias in the coefficient and lower the predictive power of the equation. A new factor must be introduced to resolve the contradiction.

Let X_k be the fraction of initial claimants assigned a potential duration of k weeks.

Then $$I_{tk} = X_k I_t. \tag{3.16}$$

$$\sum_{k=i+1}^{K} I_{t-i,k} = \left(\sum_{k=i+1}^{K} \lambda_k \right) I_t = \delta_i I_t \qquad (3.17)$$

where $\delta_i = \sum_{k=i+1}^{K} \lambda_k$ is the fraction of initial claimants receiving a determination of more than i weeks. In other words δ_i is the fraction of initial claimants who will not have exhausted their payments i weeks after their initial claim.

Analysis of disaggregate data for all of Michigan suggests

$$\lambda_k = \begin{cases} 0, & k < 11 \\ \alpha, & 11 \le k < 26 \\ \beta, & k = 26 \end{cases} \qquad (3.18)$$

where $\alpha \approx .037$ and $\beta \approx 0.44$.*

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*Verbal explanation: The shortest potential duration is 10-1/2 weeks (ten full payments and a half payment in the eleventh week). This potential duration is assigned to people who have worked 14 weeks in the year preceding their layoff. The maximum potential duration is 26 weeks and is assigned to people who have worked 35 or more weeks in the year preceding their layoff. An eye-ball scan of the Michigan data suggests that approximately an equal number of UI initial claimants are assigned potential durations falling within each of the weekly intervals between 11 and 25 weeks. Call the fraction of initial claimants assigned a potential duration within that interval α for each such week. A significantly larger fraction, nearly half, of the initial claimants receive a maximum potential duration (26 weeks). Call this fraction β. Since all of these fractions must sum to the whole,

$$15\,\alpha + \beta = 1.$$

β is estimated as the mean fraction of initial claimants receiving maximum potential durations over a two year sample and α is calculated from the equation above.

A slightly better model would make α and β random variables, but would require the missing data.

This implies

$$\delta_i = \begin{cases} 1, & i < 11 \\ 1-(i-11)\alpha, & 11 \leq i \leq 26 \end{cases} \qquad (3.19)$$

Then

$$IU_t = \sum_{i=0}^{K} \delta_i \, b_{ti} \, I_{t-i} \qquad (3.20)$$

Equation (3.20) is very similar to equation (3.10), except that (3.20) applies to all insured unemployed workers and (3.10) applies only to insured unemployed workers with a determination of k weeks. The interpretation is also similar: I_{t-i} workers file initial claims in week t-i. i weeks later b_{ti} I_{t-i} workers are still unemployed. Only a fraction δ_i of these are still insured; the others have exhausted their benefits. This leaves δ_i b_{ti} I_{t-i} workers who are both unemployed and insured. The total of insured unemployed workers is found by adding up all of the insured unemployed workers having filed initial claims during each of the previous 26 weeks.

3.6 Specification of the Continuation Rates

r_{ti} is the conditional probability that a person will remain unemployed in week t given that the person has been unemployed i-1 weeks. The conditional probability of leaving unemployment is $q_{ti} = 1 - r_{ti}$. If we are referring to a cohort of people, r_{ti} and q_{ti} are the corresponding fractions of the cohort not finding employment and finding employment, respectively.

What can be said a priori about the functional form of the equation determining r_{ti}?

A. Kaitz (1970) has shown that r_{ti} is a rising function of i, indicating the probability of remaining unemployed rises, and the probability of becoming employed during the current week falls, as the period of one's unemployment increases.

This trend may be due to either or both of two reasons:

1) Individual explanations: The longer a worker has been unemployed the more his human capital depreciates, the less he searches for a job and the less attractive he is to employers. Therefore, the longer he is unemployed the less likely he is to find a job during the current week.

A worker may search less vigorously for a job because he becomes discouraged about the chances of finding employment after weeks of trying.* He may become less attractive to employers after many weeks of unemployment because prospective employers perceive his unemployment as evidence of his lack of ability. Furthermore the unemployed worker may explore the most promising job opportunities soon after his layoff and, failing to find employment in any of these first-choice job opportunities, he will be forced to consider progressively less encouraging firms. These later-searched firms will be less likely to hire the worker and may be less numerous as well, leading to a diminished probability of finding a job in the later weeks of his unemployment spell.

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*This is similar to the "discouraged worker" effect, except that the worker does not leave the labor force, he only fails to search as energetically as he did previously.

The above factors serve to make r_{ti} an increasing function of i, but there are a few additional factors which have the opposite effect: A worker may search more vigorously for a job after a long period of unemployment because of a decline in his personal wealth due to his reduced income.[*] Also the experience of failure to find a job may induce a decline in the aspiration level of the worker, both in terms of the wage and in terms of working conditions the worker is seeking in his next job.[**] If the worker's minimum demands fall as his spell of unemployment grows longer he might be willing to accept a poor job that he would not otherwise consider, raising his chances of finding some job in later time periods.

2) Aggregation effect: Workers with high employability leave the pool of the unemployed soonest, leaving behind the less attractive workers, who have a smaller probability of finding a job. Therefore the longer a group has been unemployed the fewer easily employable workers it contains and the smaller the fraction of the group who will become employed during the current week.

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[*] This factor may be modified by UI itself: Every person studied here is receiving income in the form of UI payments.

[**] Charles Holt (1970A) has made this the key factor in his search theory.

For the purpose of this forecasting model it is unnecessary to statistically identify the above factors. It is only required that an aggregate contour of r_{ti} for all insured unemployed workers be specified.* Here we may be guided by the assumption that continuation rates rise as unemployment lengthens, at least during the first few months of unemployment. This is supported by empirical evidence (Kaitz 1970 and Perry 1972) and the preponderance of *a priori* reasons.

B. The continuation rates must be a function of a variable which expresses the excess of supply over demand for labor during the current period. This variable will be referred to as E_t. It may be the SMSA unemployment rate, or the SMSA rate of accessions in manufacturing, or some other variable.

C. The influence of aggregate excess labor demand upon continuation rates is not necessarily independent of the duration of unemployment. Aggregate excess demand for labor may be critical for a worker unemployed a long time, but only of marginal importance for a newly unemployed worker. The opposite is also possible. These eventualities should be allowed with an interaction term between i, the current duration of unemployment, and E_t, the indicator of the demand for labor.

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*For the purpose of studying the hiring process and the job search behavior of unemployed workers it is desirable to evaluate the relative importance of the above factors. It is possible to achieve this goal with the present model by fitting it to data disaggregated into homogenous subgroups.

D. Continuation rates are confined to the interval [0,1]. The functional form of the continuation rates must allow this as a possibility. This excludes any functional forms which are linear in the variable i, because the continuation rates would become infinite as the duration of unemployment becomes infinite.

A specification has been chosen which meets all of the *a priori* requirements and is exponential in the duration of unemployment (i), but linear in the excess demand for labor (E):

$$r_{ti} = a_1 + a_2 e^{a_3 i} + a_4 e^{a_5 i} E_t + \varepsilon_t \tag{3.21}$$

$$0 < a_1 < 1$$

$$a_2 < 0$$

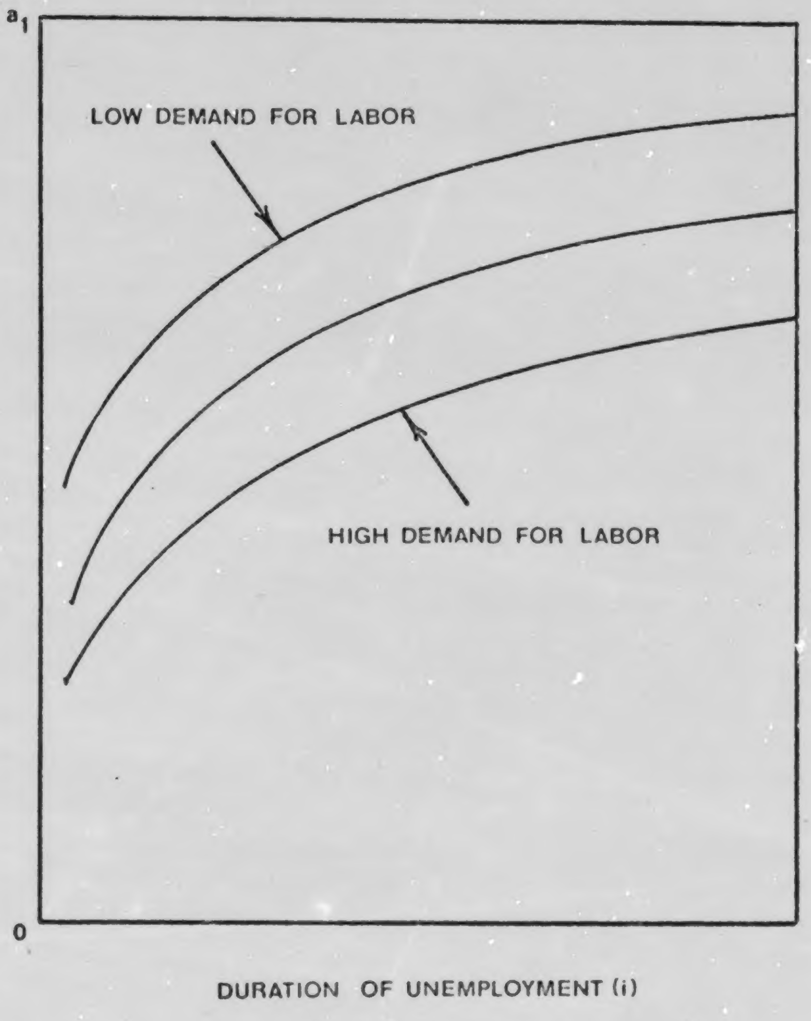
$$a_3 < 0$$

ε_t is a random variable, independently identically distributed with zero mean.

Specification (3.21) is diagrammed in figure 3.2. r_{ti} is bounded by the value a_1 if a_5 is negative. r_{ti} will rise and fall with E_t, but not necessarily the same amount for different durations of unemployment. The interaction term between E_t and the exponential of i allows the continuation rate to fall with an increase in the demand for labor and allows the influence of labor demand to damp or increase with the duration of unemployment.

Figure 3.2 Specified Functional Form of Continuation Rate For IU and EX Equations

$$\bar{r}_{ti} = a_1 + a_2 e^{a_3 i} + a_4 e^{a_5 i} E_t$$



3.7 The Insured Unemployment Equation as an Extension of a Markov Process

The present model can be thought of as being derived from the class of models known as Markov chains.

A Markov chain[*] is characterized by various "states" and the matrix of probabilities of transitions between states. An individual must be in one of these states at any one time. In the "simple" Markov chain the process obeys three assumptions:

1) Stationarity. The individuals' transition probabilities are constant through time.
2) Markovian assumption. The transition probabilities depend only upon the current state of the individual and not upon his history of previous states.
3) Homogeneity of the population. The various members of the population are assumed to have the same transition probabilities. This assumption allows the model to identify the transition probabilities of the entire population with the transition probabilities of each individual in the population.

In this context the present UI process can be represented by a cohort of individuals who make an initial claim for UI in week t-i and make continued claims for UI for i-1 weeks. In week t they have three "destination states":

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[*] The discussion of assumptions borrows from McFarland (1970).

State*	Probability
1) Make another UI claim	$r_{ti} - e_{ti}$
2) Find employment	$1 - r_{ti}$
3) Exhaust payments without finding employment	e_{ti}

Since we are looking at the entire cohort of individuals who make initial claims in week t-i this cohort will contain within it various "potential durations" and some fraction of the individuals in it, e_{ti}, will exhaust benefits.** The individuals will make another UI claim if they fail to find employment but do not exhaust payments. Therefore the fraction of the cohort remaining in this state is $r_{ti}-e_{ti}$. The probability of finding employment is unity minus the probability of not finding employment.

The above three probabilities form the first column of the Markov transition matrix:

$$\begin{array}{lc} & \text{Origin State} \\ \text{Destination State} & \begin{array}{ccc} 1 & \quad 2 & \quad 3 \end{array} \\ P_{ti} \; = \; \begin{array}{c} 1 \\ 2 \\ 3 \end{array} & \begin{bmatrix} r_{ti} - e_{ti} & 0 & 0 \\ 1 - r_{ti} & 0 & 0 \\ e_{ti} & 0 & 0 \end{bmatrix} \end{array}, \quad i = 1, \ldots, 26$$

(3.22)

---

[*] Another possible destination state would be for the individual to leave the labor force. However UI recipients are paid substantially not to do so, or at least not to admit doing so. Therefore UI data can not be used to study this state.

[**] The value of e_{ti} is calculated in Appendix A.

The first column of probabilities sums to one as required. The other six probabilities are either impossible or can not occur in the present data set.

The above matrix represents an extension of the simple Markov transition matrix. First consider the dependence of the probabilities upon the variable i. This may be considered a relaxation of either assumption (1) or assumption (3) above or both. If non-stationarity is allowed we may assume the chance of an individual making a particular transition depends upon how long he has been unemployed. This corresponds to explanation (1) of section 3.6. If heterogeneity is allowed we may assume constant, but different transition matrices for each individual. Explanation (2) of section 3.6 assumes the r_{ti} are different for different individuals. The e_i must be unequal across individuals (heterogeneity) since in general UI claimants have different determinations and will exhaust their benefits after different numbers of weeks of payments. This heterogeneity will lead to an expected population transition matrix in which the transition probabilities are functions of i (McFarland 1970).

It is possible to distinguish between non-stationarity and heterogeneity of the transition matrix by partitioning the population into homogeneous subsets. The transition probabilities of the population subsets can then be compared to determine whether significant differences have been discovered. A test for dependence of the transition probabilities upon i can also be performed at the disaggregate level to test for non-stationarity of the i-dependent type. It is probable that both heterogeneity and non-stationarity of the above types exist.

The dependence of P_{ti} upon t allows further non-stationarity of the transition matrix. The necessity of this extension follows from the effects of changing economic conditions upon a worker's chances of finding employment. Stationary Markov chains are capable of making predictions in such an environment only a few periods ahead, an unsatisfactory result for this project. The non-stationary chain describes the UI claimant as subject to continuously changing transition probabilities and should remain accurate over a much longer range of time than a stationary model would.

3.8 Differences in Data

A substantial difference between this and other Markov estimations is not theoretical but relates only to the type of data available. In usual Markov estimations, observations exist before and after a 1-step transition so that the transition probabilities can be easily estimated. In the present case the observations are available only after a series of i transitions have been completed. In a simple Markov chain the i-step transition matrix would be merely the i-th power of the 1-step transition matrix. In this case each of the transition matrices between an initial claim and a continued claim i weeks later are different, and so the i-step transition matrix is the product of the intervening transition matrices.

$$P_{ti}(i) = \prod_{m=0}^{i} P_{t-m,i-m} \qquad (3.23)$$

where $P_{ti}(i)$ is the i-step transition matrix for individuals starting in week t-i.

This new transition matrix can be applied to a vector of the number of individuals in each of the three "origin" states to determine their numbers after the i-week period.

$$X_{ti} = P_{ti}(i)\, X_{t-i,0} \qquad (3.24)$$

where X_{ti} = column vector of numbers of people in defined states in time t after i transitions.

Furthermore the data that exist are aggregate data, not subdivided by the length of stay in a particular state. For such data

$$X_t = \sum_{i=0}^{K} X_{ti} = \sum_{i=0}^{K} P_{ti}(i)\, X_{t-i,0} \qquad (3.25)$$

The model derived earlier is merely a single scalar equation of this matrix equation, the equation for the state "make UI claim." This identity is shown in Appendix B. Note that the other two scalar equations would predict the number of individuals in the "employment" and "exhaustion" states. These equations will be estimated later.

3.9 Exhaustions

Exhaustees are workers who have received their last UI payment and are no longer eligible for UI, but are still unemployed. If a worker is laid off and makes an initial claim he is given a "potential duration," a fixed number of weeks for which he will be eligible for benefits. The potential duration cannot exceed 26 weeks and may be as short as 11 weeks, depending upon how long he was at his previous job. Over the last six years an average of 44% of initial claimants received the maximum duration of 26 weeks.

Suppose the worker makes his initial claim in week t and is given a potential duration of k weeks. He will receive his first payment in week t+1 and his final payment in week t+k. If he is still unemployed thereafter he becomes an exhaustee. The data on exhaustions reported by MESC branches is a count of the number of final payments made during each month.

3.10 Benefit Exhaustions Equation

The benefit exhaustions equation is very similar to the insured unemployment equation because exhaustees must have been insured unemployed workers in the weeks previous to the current week. The only difference between an insured unemployed worker and an exhaustee is that the exhaustee has come to the end of his potential duration of payments. The number of exhaustions can be expressed as the number of workers unemployed i weeks and who also have a determination of i weeks (k=i). Writing this out in an equation,

$$EX_{ti} = X_i(b_{ti}I_{t-i}). \tag{3.26}$$

The expression in parentheses represents the number of workers making initial claims in week t-i who are still unemployed in week t. The number of people exhausting benefits in week t will be only the fraction of this group with a determination of i weeks. So the number of benefit exhaustions arising from initial claims made i weeks earlier is found by multiplying the parenthesized expression by X_i (see Section 3.5). The total number of exhaustions is the above number summed over all previous weeks:

$$EX_t = \sum_{i=0}^{K} X_i\, b_{ti}\, I_{t-i} \tag{3.27}$$

This is the exhaustions equation. The only difference between the exhaustions equation and the insured unemployment equation (3.20) is that the weights of the summation in the former case are $\{X_i\}$, the fraction of initial claimants with a determination of exactly i weeks, rather than $\{\delta_i\}$, the fraction of initial claimants with determinations of i weeks or greater. The difference reflects the fact that we are now interested in the number of people who do exhaust benefits in the current week, rather than those who have not yet exhausted their benefits in the current week.

The continuation rates, which again determine b_{ti} according to equation (3.7), are specified and estimated in the same way as they are for the insured unemployment equation.

3.11 Estimation of the Insured Unemployment and Exhaustions Parameters

Three equations constitute the continued claims model:

1. $$IU_t = \sum_{i=0}^{K} \delta_i b_{ti} I_{t-i} \qquad (3.20)$$

2. $$b_{ti} = \prod_{m=0}^{i} r_{t-m,i-m}$$

3. $$r_{ti} = \bar{r}_{ti} + \varepsilon_t \qquad (3.28)$$

where $\bar{r} = E(r_{ti})$ follows the specification in Section 3.6. Let

$$\bar{b}_{ti} = \prod_{m=0}^{i} \bar{r}_{t-m,i-m} \qquad (3.29)$$

Then

$$IU_t = \sum_{i=0}^{K} \delta_i \bar{b}_{ti} I_{t-i} + U_t \qquad (3.30)$$

where U_t is a random term whose form and properties are derived in Appendix C. Equation (3.30) is of the form

$$IU_t = \overline{IU}(a_1,\ldots,a_5;\ E_t,\ldots,\ E_{t-26},I_t,\ldots\ I_{t-26}) + U_t \qquad (3.31)$$

where the function $\overline{IU}$ is non-linear in the parameters a. A non-linear least-squares method of estimation has been chosen to estimate the parameters. The method minimizes the error mean square,

$$s^2 = \frac{1}{n-p} \sum_{t=1}^{n} \left[IU_t - \overline{IU}(\hat{a};E,I) \right]^2 , \qquad (3.32)$$

by means of stepwise Gauss-Newton iterations. It will converge to consistent estimates of the parameters under the assumptions of fixed independent variables and zero expectations of the error term U_t. Appendix C shows that the error term has zero expectation, but is autocorrelated to the K-th degree. Appendix D shows how the non-linear least squares method can be used to estimate the residual autocorrelation parameters simultaneously with the structural parameters. Using this method a new disturbance term is minimized which is not autocorrelated. The result is an improvement in the efficiency of the estimation.

CHAPTER IV

EMPIRICAL RESULTS FOR THE INSURED UNEMPLOYMENT AND EXHAUSTIONS EQUATIONS

4.1 Use of Monthly Data

In order to use monthly data to estimate the IU and exhaustions equations, which have been specified in weekly terms, the model must be summed over the 4.3 weeks which comprise a month. In this process it is desirable to retain the current definition of the continuation rate as the probability of remaining unemployed another week given an unemployment spell of i weeks. This can be accomplished subject to the necessary assumption that continuation rates be constant during a single month. The details of this process are given in Appendix E.

Monthly data permit specifications of the continuation rates which allow the continuation rates to rise and fall with changes in the tightness of the labor market. The tightness of the labor market is expressed in the labor market indicator E_t. Several quantities were tried as E_t, and tested according to their ability to explain continuation rates.

4.2 Comparison of Specifications of the Continuation Rates

A comparison of the resulting estimations appears in Table 4.1. Statistics to the left of the double line are calculated from the insured unemployment equation (3.20) and statistics to the right of the double line are from the exhaustions equation (3.28). Both of these equations require specification of the continuation rates; different specifications of these rates are listed vertically down the page. All of the specifications have the same functional form (3.21), but different assumptions are made about the parameters (a_i) and about the variable E_t.

Specifications 1 and 2 do not use any of the variables E_t and are calculated for comparison purposes. The first requires the continuation rates to be constant and the second allows them to vary only with the duration of unemployment. Estimation 1 calculates the continuation rates at .79 and .86 respectively for the IU and exhaustions equations. Both of these estimates should be taken as averages over the 26 weeks of insured unemployment, with more weight given in the exhaustions equation to the later weeks of unemployment. Since later continuation rates are higher, the estimated rates are higher for the exhaustions equation.

The more realistic specification 2 improves the explanatory power of the two equations and adds some information about the behavior of continuation rates. The negative signs of a_2 and a_3 indicate that continuation rates rise, but at

TABLE 4.1 ESTIMATIONS OF THE INSURED UNEMPLOYMENT AND EXHAUSTIONS EQUATIONS

Functional Form For Continuation Rates: $\bar{r}_{ti} = a_1 + a_2 e^{a_3 i} + a_4 e^{a_5 i} E_t + a_6 D_t$

Data: January, 1966 through December, 1971

Equation:		Insured Unemployment			Exhaustions		
No.	Specifications of Continuation Rates	Mean Squared Error (10^5)	R-SQR	Parameters	Mean Squared Error	R-SQR	Parameters
1	Continuation rates constant ($a_2=a_3=a_4=a_5=a_6=0$)	25.5	.633	$a_1 = .79$ (.0076)	1024.	.379	$a_1 = .87$ (.0029)
2	Continuation rates rise with the duration of unemployment ($a_4=a_5=a_6=0$)	18.4	.735	$a_2=-.96$ (.039) $a_3=-.036$	977.	.407	$a_2=-.81$ (.039) $a_3=-.0068$ (.004)
3	Rates change with $E_t = u_t$ ($a_6=0$)	9.10	.867	$a_4= .014$ (.017)	443.	.727	$a_4= .014$ (.014)
4	$E_t = A_t$ ($a_6=0$)	10.1	.855	$a_4=-.0086$ (.007)	398.	.754	$a_4=-.018$ (.005)
5	$E_t = A_t/u_t$ ($a_6=0$)	5.84	.916	$a_4=-.024$ (.012)	280.	.827	$a_4=-.018$ (.011)

TABLE 4.1 (Concluded)

Equation:		Insured Unemployment			Exhaustions		
No.	Specifications of Continuation Rates	Mean Squared Error (10^5)	R-SQR	Parameters	Mean Squared Error	R-SQR	Parameters
6	Same with auto layoff dummy ($a_6 \neq 0$)	4.72	.933		284.	.828	
7	$E_t = (A_t - \%Q_t)/u_t$	4.91	.929	$a_4 = -.047$ (.030)	240.	.854	$a_4 = -.015$ (.012)
8	$E_t = \%REH_t/u_t$	7.14	.897	$a_4 = -.14$ (.13)	255.	.845	$a_4 = -.16$ (.097)
9	$E_t = A_t/u_t$ autocorrelated error	2.89	.963		195.	.896	
10*	$E_t = A_t/u_t$ ($a_1 \leq 1$) autocorrelated error	3.08	.961		195.	.896	

*Selected as final estimation

a declining rate as the duration of unemployment rises. This is in agreement with the discussion of section 3.6. These two estimations produce some confidence in the method, but neither specification explains enough of the variance to be acceptable for projection purposes.*

The Detroit SMSA unemployment rate is most often used as the indicator of labor market tightness, and so it is tried here to explain continuation rates. The introduction of the unemployment rate substantially improves both equations, and the positive sign on a_4 implies, as expected, that continuation rates rise during periods of high unemployment. The MSE of each equation is reduced by more than half, and the predictive power of the equation is much improved. This result lends substantial justification to the use of non-stationary continuation rates.

The unemployment rate can be criticized as being too inclusive to accurately reflect the probability of finding employment. The unemployment rate is a stock variable produced by two distinct labor turnover flows: losing a job to enter unemployment and finding a job to leave unemployment.** Only the latter transition determines continuation rates, and the frequency of this transition is measured in the SMSA rate of accessions. Specification 4 uses the rate of accessions to drive the continuation rates,[*] giving an improvement in the exhaustions equation, but a slight deterioration in the IU equation.[**] The negative sign of a_4 indicates that continuation rates rise when accession rates fall, as expected. The estimation does not provide a clear-cut decision as to whether the unemployment rate or the accessions rate should be the preferred driving variable, but confirms that both variables explain some variance.

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*Specification 2 is about as good as simple linear approaches to the estimation. A linear regression of the form $IU_t = \sum_{i=0}^{K} b_i I_{t-i} + \varepsilon_t$ (b_i's are constants) allows a more complex time dependence than Specification 2, but still assumes stationary continuation rates. Such a linear regression is found to predict better than Specification 2 but not nearly as well as Specification 3.

**As well as transitions into and out of the labor force.

A closer look at the labor market suggests than an interaction between the two variables can explain more variance than either of them separately. Consider the probability that a particular individual in a pool of NU homogeneous unemployed workers will find employment. If NA workers are hired from the pool, the individual's chance of being among them is NA/NU. This ratio will equal one minus the individual's continuation rate and will represent an average continuation rate in a heterogenous labor pool. It expresses accessions as a fraction of the number of unemployed, rather than as a fraction of the number of employed, as does the accession rate. If we create an interaction variable equal to the ratio of the accession rate to the unemployment rate (A/u), this variable will be approximately equal to NA/NU[*] and can be used as a powerful driving variable for the continuation rates. Line 5 shows that the new interaction variable is a substantially better predictor than is either A or u. The MSE in predicting both insured unemployment and exhaustions falls by almost half and the R-SQR's rise by 5 to 10 percent. The negative sign of a_4 indicates that continuation rates rise as the new variable falls, as expected.

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[*] Since the Labor Turnover Sample, which provides the data on accessions, is sparse in the non-manufacturing industries, only the manufacturing accessions can be used.

[**] The deterioration of the IU equation may be due to the method of calculating the unemployment rate. Since the unemployment rate is calculated from insured unemployment, there is a definitional link between u and IU, which does not exist between A and IU (section 2.2).

Specification 7 introduces a special effect in July due to the annual auto layoffs. The workers unemployed by these layoffs are nearly certain to be rehired within a month and so do not search for other work. It is also possible that they may not be employed long enough to collect benefits, even though they make an initial claim. These characteristics separate auto layoff workers from other unemployed workers and so a dummy variable has been defined to represent them. The dummy variable has a value of one in July for the cohort of people in their first month of unemployment, and zero otherwise. The specification improves the IU equation enough to justify its continued use.

Some accessions merely count people who quit one job

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[*] $$\frac{A}{u} = \frac{NA/NE}{NU/NL} = \frac{NA}{NU}\left(\frac{NL}{NE}\right) = \frac{NA}{NU}\left(\frac{NE + NU}{NE}\right) = \frac{NA}{NU} + \frac{NA}{NE}.$$

NA = number of accessions, NU = number of unemployed, u = unemployment rate, NE = employment, NL = labor force. The second term will be negligible, about 1/20th the size of the first term, because NE is at least an order of magnitude greater than NU.

to accept another without passing through unemployment and without receiving UI. Thus accessions might rise during a period of high job turnover merely because quits have risen, without the insured unemployed gaining any better chance to find a job. Specifications 7 and 8 represent two attempts to quantify this effect so as to better predict the employment prospects for the insured unemployed. Specification 7 is the same as specification 6 except that instead of accessions in the numerator of the driving variable it substitutes accessions minus quits, that is, the number of accessions not accounted for by simultaneous quits. The success of this specification depends upon the majority of quitting workers being "job changers" rather than entrants to the unemployment pool. Otherwise their accession to a job should be counted. The empirical results do not clearly indicate whether this specification is an improvement over specification 6, since it improves the exhaustions equation but detracts from the IU equation. Because only a substantial improvement would justify introducing the new turnover variable, quits, the specification was dropped.

Specification 8 limits our view of accessions to only "rehires," workers hired after a temporary layoff from the same firm.* This quantity will exclude job changers, but will also exclude unemployed people who find new jobs. The empirical result is ambiguous and the specification was dropped. The error introduced by the phenomenon of job changers is therefore left as a random factor, fortunately a small one.

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*Accessions = New hires + rehires. Rehires are reported monthly by the Job Openings and Labor Turnover Sample.

Line 9 uses specification 6 for the continuation rates, but estimates the model assuming an autocorrelated error term to improve the efficiency of the estimation (Appendix D). The autocorrelated specification results in a substantial improvement in the mean squared error of both equations. Furthermore almost all of the six autocorrelation coefficients are significant, in the sense that the coefficients are substantially more than their standard errors. Thus the *a priori* specification of the error process is confirmed and the over-all equation is improved in predictive ability.

Only a minor difficulty remains in that the estimated value of a_1 is very slightly greater than 1. Since a_1 is the asymptotic value of the continuation rate, it makes no sense for a_1 to be greater than 1.0. Furthermore the difference between a_1 and 1.0 is not significant. It was decided therefore to impose the restriction that a_1 be less than or equal to 1.0. The restriction of course increases the mean squared error of the equations, but the increase is so slight that the constraint must be considered entirely compatible with the data. This is especially true for the exhaustions equation, where the mean squared error increases only about .01%.

The above recapitulation describes the non-linear estimation process employed for the insured unemployment and exhaustions equations. It is not quite as simple as the familiar linear estimation process, yet the same guide is used: minimize the mean squared error of the equations subject to a priori knowledge of the statistical processes. The final results are two equations which can be expected to predict well and correspond with our view of the reemployment process.

4.3 Predictive Ability of the Equations During the Sample Period

Table 4.2 and Figures 4.1 and 4.2 compare the observed and predicted values of the final insured unemployment equation and exhaustions equation respectively, over the sample period. In both cases the equations predict values very close to the actual values, and in neither case do the equations reveal systematic error. These figures give further evidence of the predictive power of the final equations.

4.4 Estimated Continuation Rates

Table 4.3 lists the parameters estimated from the final IU equation and the final exhaustions equation, together with their approximate standard errors.* Table 4.4 presents the

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*Since the estimating function is non-linear in its parameters the standard errors can not be calculated exactly. They are estimated by a first-order Taylor series approximation. See Appendix G.

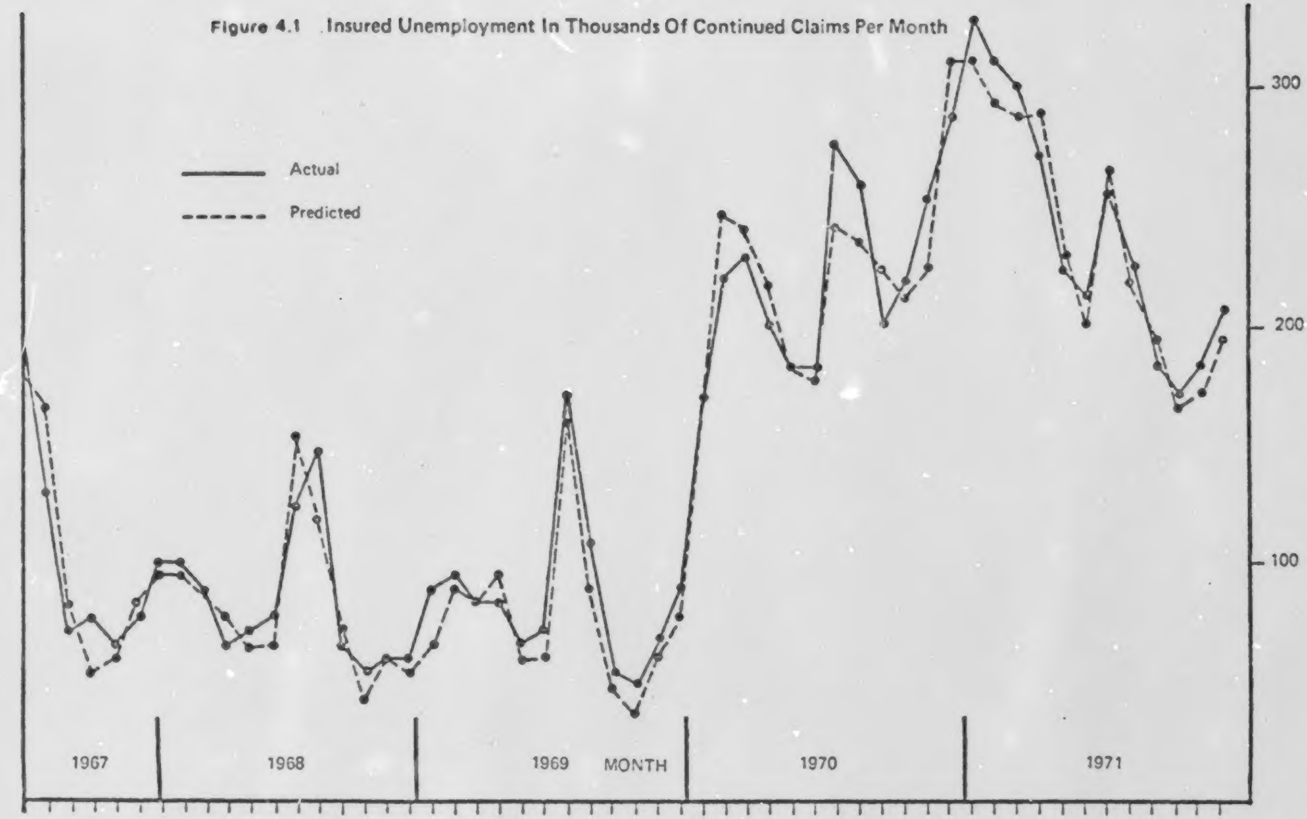

Figure 4.1 Insured Unemployment In Thousands Of Continued Claims Per Month

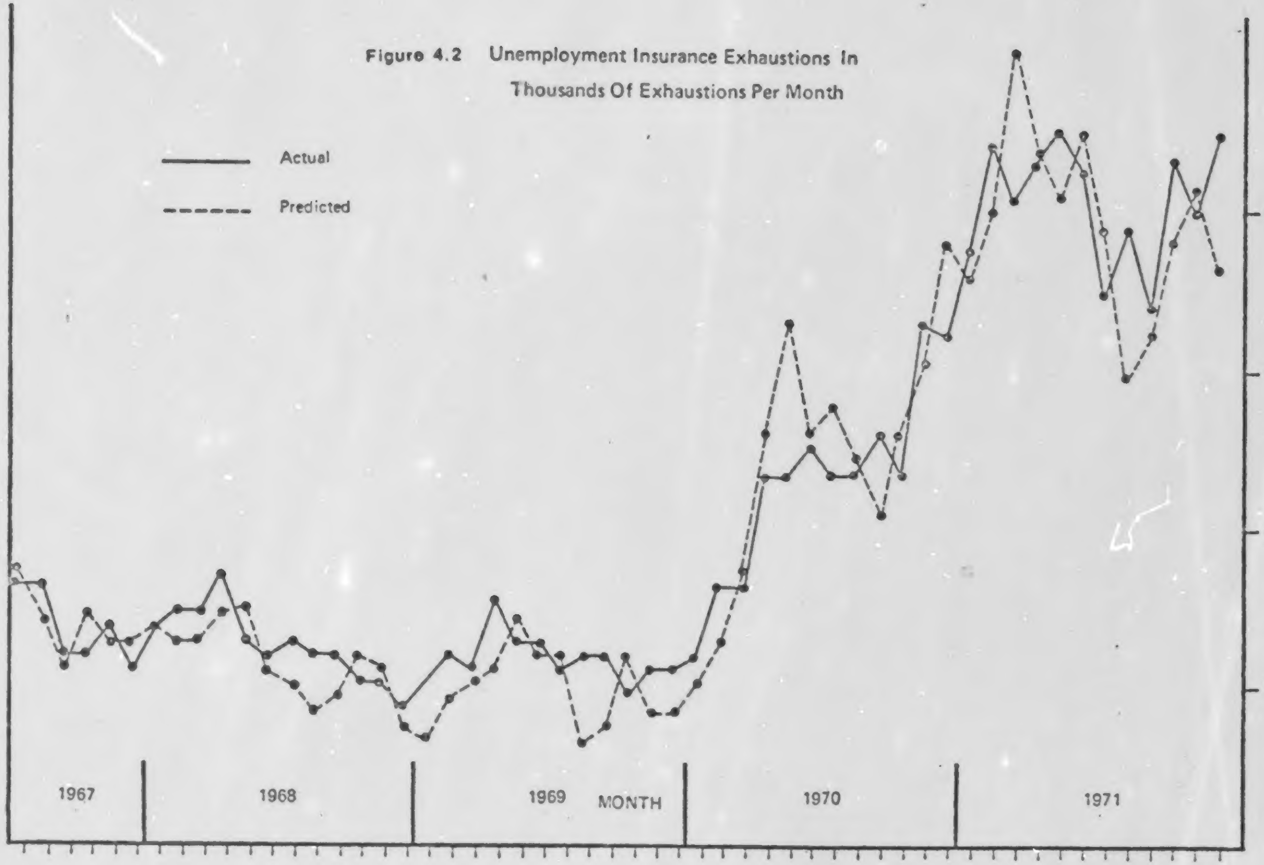
Figure 4.2 Unemployment Insurance Exhaustions In Thousands Of Exhaustions Per Month

TABLE 4.2

COMPARISON OF PREDICTED VALUES WITH ACTUAL VALUES FOR INSURED UNEMPLOYMENT AND EXHAUSTIONS

Year	Month	Insured Unemployment		Exhaustions	
		Actual	Predicted	Actual	Predicted
1967	2	135419	153392	1093	1004
	3	152300	174676	1308	1187
	4	134142	155697	1870	1873
	5	101159	116610	1895	2612
	6	86358	96555	1532	2087
	7	194165	191546	1632	1741
	8	135954	170122	1675	1508
	9	73704	85164	1198	1099
	10	81868	59191	1175	1517
	11	68361	65322	1328	1236
	12	86037	89013	1141	1327
1968	1	108044	104163	1392	1369
	2	98849	97942	1396	1256
	3	95148	98242	1493	1281
	4	72672	78831	1682	1446
	5	75829	72215	1284	1553
	6	84345	72090	1202	1089
	7	132658	162592	1297	1022
	8	151553	125587	1196	867
	9	71394	77985	1173	957
	10	59077	49637	1056	1229
	11	66534	62460	992	1084
	12	69226	58525	902	752
1969	1	96621	74884	1041	701
	2	93055	88278	1105	887
	3	88886	91748	1144	1055
	4	85137	96036	1498	1087
	5	70085	68135	1327	1507
	6	76980	65472	1234	1147
	7	163358	179434	1095	1233
	8	113680	93226	1249	676
	9	56763	55881	1181	747
	10	55608	43484	933	1249
	11	69357	65154	1135	848
	12	97923	84773	1158	842

TABLE 4.2 (Concluded)

Year	Month	Insured Unemployment		Exhaustions	
		Actual	Predicted	Actual	Predicted
1970	1	179933	177379	1198	1028
	2	204599	230093	1527	1214
	3	235860	249383	1669	1797
	4	200511	214944	2307	2609
	5	187376	188396	2434	3422
	6	180471	178107	2520	2555
	7	284372	248428	2438	2867
	8	263519	241177	2383	2485
	9	199743	221067	2547	2084
	10	226281	219607	2391	2697
	11	251145	220731	3324	3018
	12	296558	316231	3331	3921
1971	1	334986	315394	3826	3703
	2	288932	273300	4165	3723
	3	307436	295845	4229	5208
	4	268521	282639	4365	4418
	5	230342	238402	4641	4205
	6	210219	198873	4238	4487
	7	259709	268556	3598	4027
	8	231192	223008	4012	3014
	9	181422	195414	3413	3192
	10	175872	172118	4452	3969
	11	181623	172032	3960	4181
	12	211401	199817	4641	3749

TABLE 4.4

CONTINUATION RATES ESTIMATED FROM INSURED UNEMPLOYMENT EQUATION

Labor Demand:	Low		Average		High	
Weeks of Unemployment	Rate	Standard Error	Rate	Standard Error	Rate	Standard Error
2	.693	.027	.648	.027	.603	.035
4	.797	.010	.759	.014	.721	.021
6	.864	.019	.832	.018	.800	.019
8	.908	.020	.881	.017	.853	.019
10	.937	.017	.913	.016	.890	.022
12	.956	.013	.936	.017	.916	.026
14	.968	.011	.952	.018	.935	.030
16	.977	.009	.963	.020	.949	.033
18	.983	.009	.971	.021	.959	.034
20	.987	.009	.977	.021	.967	.035
22	.990	.009	.981	.021	.973	.034
24	.992	.009	.985	.021	.977	.033
26	.994	.008	.987	.020	.981	.032

CONTINUATION RATES ESTIMATED FROM EXHAUSTIONS EQUATION

Labor Demand:	Low		Average		High	
Weeks of Unemployment	Rate	Standard Error	Rate	Standard Error	Rate	Standard Error
2	.849	.027	.820	.042	.792	.068
4	.857	.019	.831	.029	.805	.047
6	.866	.013	.842	.018	.818	.029
8	.873	.007	.852	.009	.830	.015
10	.881	.004	.861	.004	.841	.008
12	.888	.005	.869	.008	.851	.013
14	.894	.008	.877	.013	.860	.021
16	.900	.011	.885	.018	.869	.028
18	.906	.014	.892	.022	.878	.034
20	.911	.017	.898	.025	.885	.038
22	.916	.020	.905	.028	.893	.042
24	.921	.022	.910	.030	.899	.045
26	.926	.024	.916	.032	.906	.047

continuation rates calculated by substitution of the estimated parameters into the functional form (3.21) of the continuation rates. The rates are arranged with different rows corresponding to different durations of unemployment and different columns corresponding to different labor demands.

Figures 4.3 and 4.4 diagram the continuation rates estimated from the IU and EX equations. The diagrams have been arranged so that the horizontal axis is the duration of unemployment and different contours represent differing labor demands. The lowest contour pictures continuation rates in a tight labor market, the middle contour, in an average labor market and the highest contour in a loose labor market. The demand for new workers is quantified in the variable E_t (=A/u): an "average" labor market occurs when E_t is equal to its mean value and a "tight" or "loose" labor market occurs when E_t is a standard deviation above or below its mean value.

4.5 Implications of the Estimated Continuation Rates:

The following observations can be made about the estimated continuation rates:

1) The estimated continuation rates are in the interval $[0,1]$ as is required by their interpretation as a probability.

2) For a given unemployment duration, a lower continuation rate always accompanies a higher labor demand, and vice versa. This leads further credence to the definition of continuation rates as the probability of remaining unemployed.

Figure 4.3 Continuation Rates Estimated From Insured Unemployment Equation

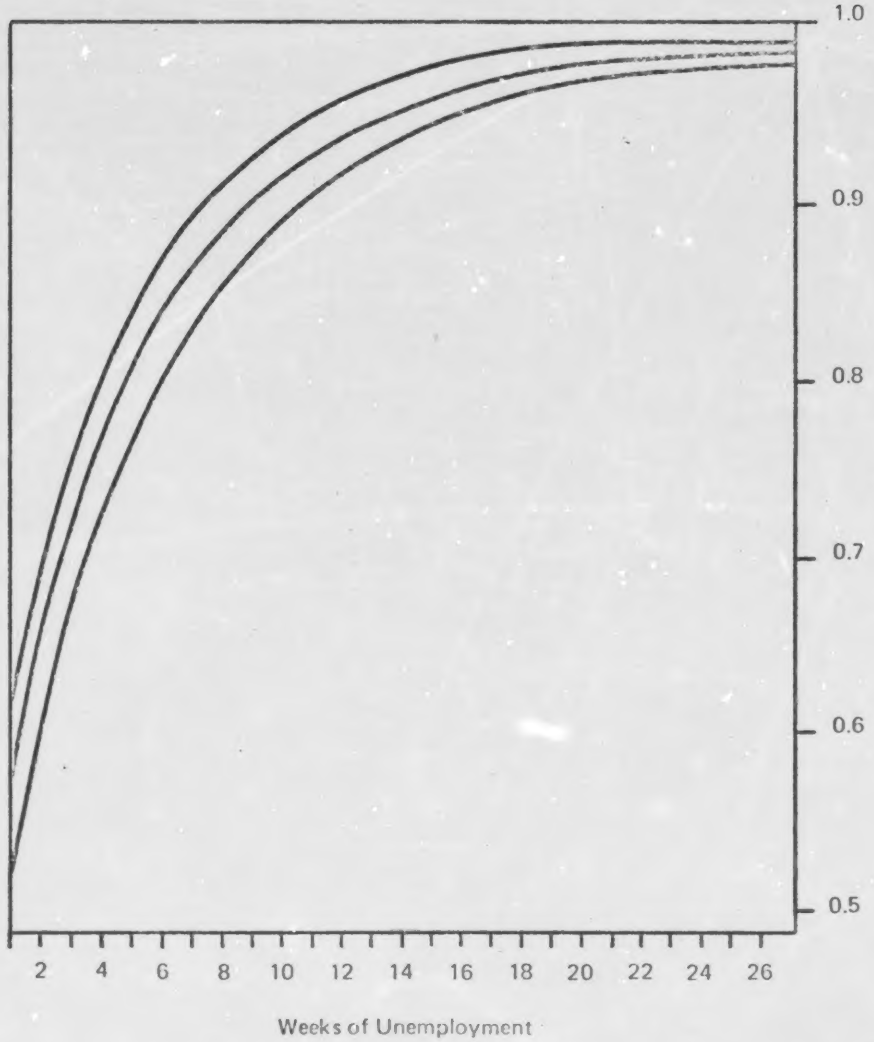

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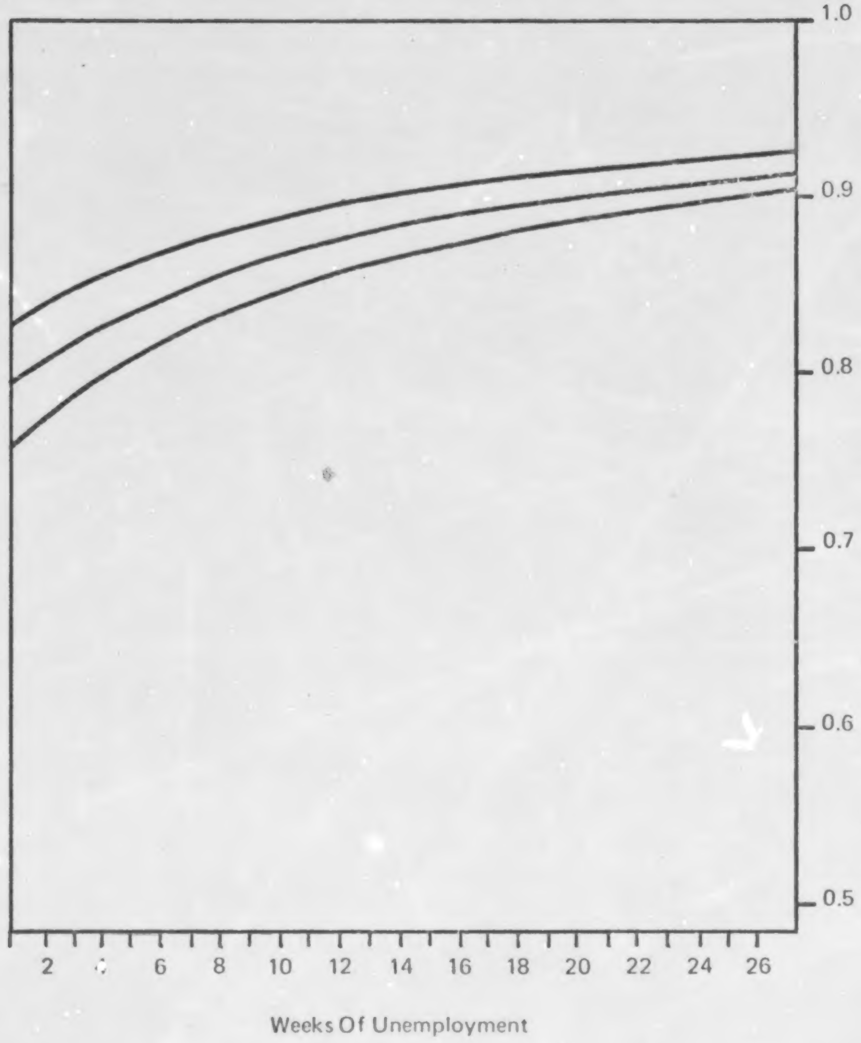
Figure 4.4 Continuation Rates Estimated From Exhaustions Equation



3) Continuation rates rise with duration for the entire 26 weeks of unemployment insurance payments, indicating that the longer an unemployed worker remains unemployed the less chance he has of finding employment during a succeeding time interval. This result is in agreement with both a priori reasoning and empirical results from other studies (section 3.6). The effect is most clearly visible in rates from the IU equation, which have narrower confidence intervals, but is also apparent in the rates from the exhaustions equation.

This should be considered one of the dominant features of job search. It is useful to think of the unemployed as being ordered in a queue, rather than being an amorphous "pool" or a "reserve army." An unemployed worker has a position in the queue defined by his probability of being hired during the next week: the higher a worker's chance of being hired, the closer he is to the head of the queue. A particular worker will be positioned by his age, race, sex, skills, etc. as well as his duration of unemployment. The empirical finding of rising continuation rates means that the longer a worker has been unemployed the further back in the queue he is likely to be found.

4) All three continuation rate curves are asymptotic to the value one. A continuation rate of one corresponds to a certainty of remaining unemployed during the next week. A worker's chance of getting a job never declines to that low a level; however, it tends to that extreme as the duration of unemployment becomes very long. A worker who has already been unemployed for many weeks has very little chance of

getting a job during the next week, though his chance never actually falls to zero. For example, an insured worker who has been unemployed 25 weeks has only about 1% chance of becoming employed during his 26th week of unemployment.

5) One surprising result of the estimation is the tight curvature of the continuation rate graphs. The curves are steeply sloped during the first eight weeks of unemployment, but flatten out for longer durations. During the first eight weeks of unemployment the continuation rate (for average labor demand) rises .31 (from .57 to .88), but during the next eight weeks it rises only 0.08 (to 0.96). Of course, any curve of the exponential form used will have a decreasing slope, but the rate of this decline is empirically estimated.

The abrupt decline in re-employment rates can also be seen in the numbers b_{ti} defined in equation (3.7). These numbers are the fraction of workers still unemployed in week t after i weeks of unemployment. Assuming "average" labor demand, b_{ti} declines from 1.0 at $i=0$ to .10 at $i=8$, and to 0.05 at $i=26$. This means that 90% of the workers laid off get jobs during the first eight weeks of unemployment, but of the remaining 10% of the laid-off workers only half of them get jobs during the entire 18 weeks remaining in the maximum UI benefit period. This makes it clear that the workers remaining unemployed after eight weeks experience a particularly difficult time finding a job as compared to the majority of workers laid off.

The most likely explanation of this phenomenon is in terms of a heterogeneous labor market. Most insured unemployed workers undergo a short spell of unemployment, 90% of them leaving the UI roles within eight weeks of their initial claim. Some of these short-term unemployed workers may even be on relatively fixed layoff, being fairly certain of recall by an auto manufacturer. The low continuation rate in the short durations reflects these workers' high probability of returning to work.

After the short-term unemployed workers have regained employment a small group of difficult to employ workers remain unemployed. The high continuation rates after eight weeks reflect their small chance of finding employment. The existence of such groups means only that continuation rates will rise; in order for the continuation rates to rise as rapidly as they do in the early weeks it is necessary that these groups be very distinct and that they have substantially different rates of re-employment. The empirical finding that continuation rates rise rapidly during the short unemployment durations is most likely evidence for a markedly heterogeneous unemployed labor force, where the heterogeneity implies markedly different rates of re-employment.

It is implausible that the steep rise of the continuation rates can be explained alternatively by rapid deterioration of an individual's chances of re-employment. The individual factors which may explain an increase in continuation rates (described in section 3.6) cannot be expected to operate so quickly as to produce drastic changes in a worker's employability within a few weeks. For example a worker's real or perceived human capital cannot be expected to depreciate rapidly during two or three weeks of unemployment. Nor is it likely that the worker slows his job search substantially during the first few weeks of unemployment.

In summary, the finding that continuation rates rise rapidly during the first few weeks of unemployment implies a substantial inequality within the unemployed labor force in terms of different workers' abilities to find jobs. This is not to deny the possibility of declining individual re-employment rates, but only that whatever individual effects occur are swamped by the aggregation effects.*

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*In fact individual re-employment rates may rise (due to declining aspirations). Aggregate re-employment rates would still fall.

CHAPTER V

FIVE LINEAR EQUATIONS: LAYOFFS, ACCESSIONS, INITIAL CLAIMS, NUMBER OF WEEKS COMPENSATED AND AMOUNT OF BENEFITS

5.1 Layoffs and Accessions

This UI model is driven by the two labor turnover variables, layoffs and accessions. In this section relationships are developed to forecast these variables from the behavior of employment.

A layoff is a separation from employment initiated by the employer without prejudice to the worker.* An accession is any permanent or temporary addition to the employment roll. Layoffs and accessions represent the primary tools** with which firms can respond to fluctuations in the demand for their products by expanding or reducing their stock of employed workers. In order to expand employment, and hence production, a firm can increase accessions and decrease layoffs. To reduce employment a firm can decrease accessions and increase layoffs. Hence there will be a close relationship between accessions and layoffs and the fluctuations in employment. This relationship should not be thought of as causative (in either direction) since it is fluctuations in product demand which produce both changes in employment and labor turnover.

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*See U.S. Bureau of Labor Statistics, Dept. of Labor, Form DL-1219.

**Other forms of labor turnover exist, but these are not primarily under the control of the firm. These include quits, discharges, deaths, retirements, etc.

If a firm decides to reduce its employment in the face of a fall in product demand will it choose to cut normal accessions or to lay workers off? The answer depends upon the duration of the reduction in employment. If the reduction in employment is expected to be brief the firm will try to avoid the costs associated with laying off workers only to rehire them, if it can, a few months later. The costs to the firm of laying off workers include the amount of UI benefits to laid off workers, the loss of job training invested in the employees, particularly in those firms with a large specific investment in their employees, and the employee search expenses incurred by the firm when it must rebuild its work force.* Different firms will experience different costs per employee, but most firms will attempt to avoid these costs by alternatives to layoffs.

As product demand falls we would expect firms to reduce their accessions and possibly the number of hours per week worked by their employees. The first of these will cause tabulated employment to fall so that a decline in employment will be associated with a reduction in accessions immediately. If the decline in product demand persists, some firms will begin laying off workers. This may occur even before accessions have been reduced to zero if the firm has a heterogeneous work force. In this case the firm may be hiring workers in one category, while laying off workers in another. In particular workers in which the firm has invested specific training or are skilled and require high rehiring costs would be less likely to be laid off and may even be hired, while unskilled workers are laid off (Barth 1971). Accessions will remain low as product demand persists, but layoffs will account for a larger part of employment reductions.

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*These costs are discussed by Barth (1971) and Holt (1960).

These conclusions follow from the cost of layoffs relative to the cost of reductions in accessions, but these factors are little guide to the length of time lags involved, which must be estimated empirically. A distributed lag model has been chosen to determine the time lags and to establish forecasting equations. The models express accessions and layoffs as a function of changes in employment in current and previous months. The lags between employment and labor turnover allow changes in employment in previous months to determine accessions and layoffs during the current month.

$$A_t = \text{monthly dummies} + a_{-1}\Delta EM_{t+1} + a_0\Delta EM_t + a_1\Delta EM_{t-1} + \dots + a_m\Delta EM_{t-m}{}^{*} \tag{5.1}$$

$$L_t = \text{monthly dummies} + b_{-1}\Delta EM_{t+1} + b_0\Delta EM_t + \dots + b_m\Delta EM_{t-m} \tag{5.2}$$

We expect a smooth, but neither strictly ascending nor descending pattern for the coefficients a and b, so we choose the Almon polynomial distributed lag technique (Almon 1965) with the simplified estimation method described by Cohen (1973, pp. 53-55) to estimate the coefficients. A polynomial of the 4th degree was chosen and a maximum lag (m) of one year (12 months) was allowed. The results appear in Table 5.1.

5.2 Empirical Results

The equations fit the employment and labor turnover data for Detroit manufacturing industries fairly well (R^2 of .90 and .80, respectively for accessions and layoffs), and the

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[*] The seemingly leading variable ΔEM_{t+1} must be included because of a discrepancy between the reported time interval for the labor turnover variables and the employment variables. Labor turnover variables such as A_t and L_t are reported over calendar months. Employment EM_t is reported as of a period near the middle of the month. (The week including the 12th of the month). Therefore ΔEM_{t+1} measures the change in employment between the middle of the next month and the middle of the current month. Since this interval includes half of the current month it is necessary to explain labor turnover in the current month.

TABLE 5.1

PARAMETERS FROM ACCESSIONS AND LAYOFFS EQUATIONS

	Accessions ($R^2 = .90$)		Layoffs ($R^2 = .80$)	
Variable	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	2.56	8.88	2.53	7.43
ΔEM_{t+1}	.00150	3.10	-.00038	-.79
ΔEM_{t}	.00176	4.32	-.00162	-3.36
ΔEM_{t-1}	.00155	3.74	-.00222	-5.47
ΔEM_{t-2}	.00114	3.04	-.00223	-5.40
ΔEM_{t-3}	.00076	2.08	-.00186	-4.96
ΔEM_{t-4}	.00055	1.42	-.00130	-3.56
ΔEM_{t-5}	.00055	1.45	-.00069	-1.81
ΔEM_{t-6}	.00076	2.10	-.00015	-.39
ΔEM_{t-7}	.00112	2.86	.00025	.698
ΔEM_{t-8}	.00143	3.27	.00047	1.21
ΔEM_{t-9}	.00158	3.32	.00049	1.13
ΔEM_{t-10}	.00096	1.52	.00035	.79
Jan	.503	1.32	-.0976	-.23
Feb	.254	.65	-.120	-.278
Mar	.999	2.32	-.735	-1.68
Apr	1.39	3.20	-.992	-2.08
May	1.63	3.79	-1.32	-2.99
Jun	2.41	5.50	-.795	-1.80
Jul	1.82	3.83	1.50	2.96
Aug	5.00	11.2	-1.15	-2.20
Sep	3.93	8.83	-1.24	-2.69
Oct	2.44	5.74	-1.14	-2.29
Nov	1.23	2.89	-.980	-2.24

estimated coefficients are in agreement with the above discussion. Figure 5.1 presents a graph of the first few coefficients of ΔEM in the two equations. These coefficients can be interpreted as the changes in manufacturing layoff rates and accession rates in current and future months that are associated with changes in manufacturing employment assumed to occur at the point in time marked ΔEM on the graph.[*]

For example suppose there is a fall in employment at ΔEM. The graph shows that it is simultaneously associated with a large reduction in accessions and a relatively smaller increase in layoffs. During the next few months further cuts in accessions are made and further layoffs occur as the fall in product demand persists. The graph shows that the peak in layoffs lags the employment decline by about two months, whereas the trough in accessions is about concurrent with the fall in employment. Furthermore the decline of accessions is quantitatively more important than the increase in layoffs during the month of the employment decline, but thereafter the increase [illegible] layoffs exceeds the fall in accessions. This is in agreement with the foregoing discussion of labor turnover since layoffs, being costly to the firm, will be delayed until all alternatives have been exhausted.

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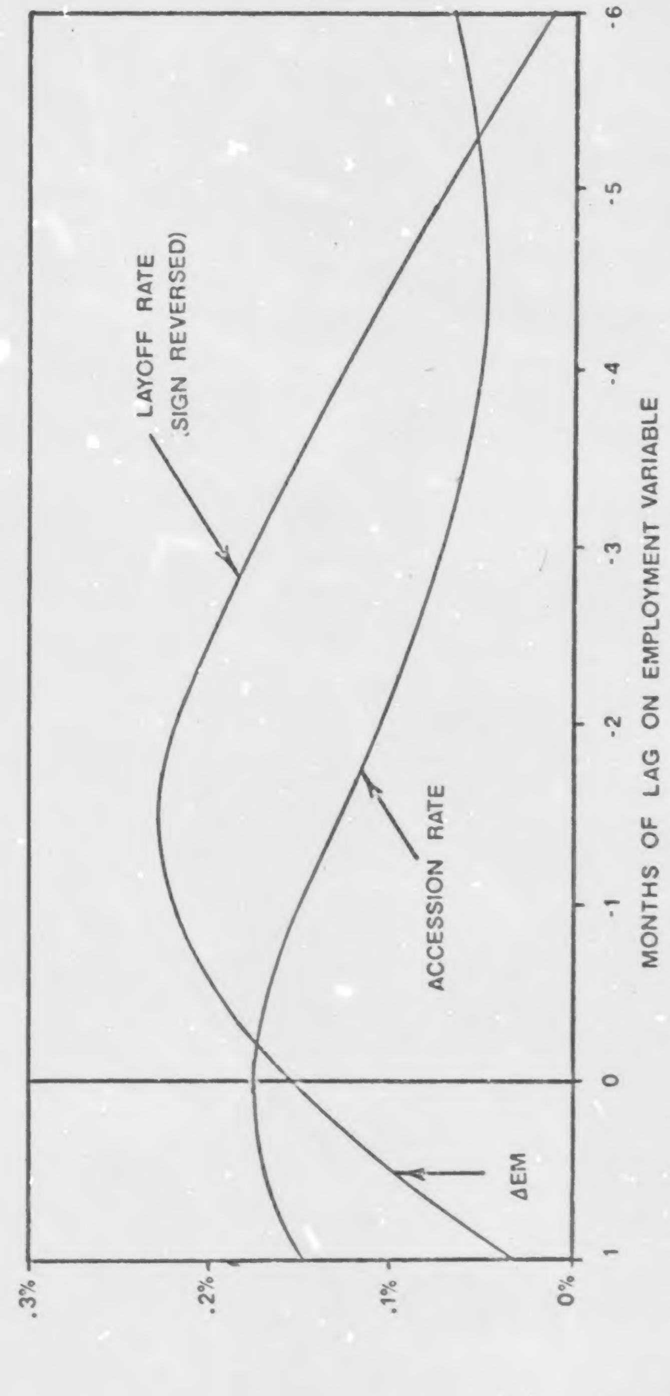
[*] The location of ΔEM a half month before time zero is explained by the different collection periods for the turnover and employment data. See footnote, p. 68.

Figure 5.1 Coefficients From Labor Turnover Equations



A reduction in accessions, having a smaller cost to the firm, can begin soon after a decline in product demand is encountered.

5.3 Initial Claims Equation

A covered worker will usually file an initial claim for UI within the week immediately following his layoff. However, the worker may delay filing for a few weeks* or may never file for UI benefits. Thus, the number of initial claims in the current week will be a function of the number of layoffs in the current week and a few previous weeks.

Special studies done in Indiana (Andrews 1957) and Ohio (1965) show that most covered workers file for UI within two or three weeks of being laid off. This means there will be initial claims arising from layoffs in both the current and previous months, since a worker laid off near the end of the previous month may make an initial claim in the current month. But only an insignificant number of initial claims will arise from layoffs more than one month before the current month. Expressing this dependence in a distributed lag,

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*Technically the worker may delay filing as long as he wants, subject only to the requirement that he have sufficient "credit weeks" (weeks of covered employment) during the year preceding his initial claim. He could delay filing up to 38 weeks and still have the minimum 14 credit weeks during the previous 12 month period. Thus, the legal restrictions on delaying filing are very loose and will rarely penalize the worker for delay. (Michigan 1971)

$$I_t = a_1 L_t + a_2 L_{t-1} \, , \tag{5.3}$$

where I_t = initial claims in month t

and L_t = layoffs in month t.

The numbers a_1 and a_2 are the (marginal) fractions of covered laid off workers who file for UI. These fractions cannot be considered constants* since they represent the outcome of workers' economic decisions as to when and whether they will file for UI.

The decisions may not be entirely rational, but they will reflect some balance between the costs and benefits of UI:

1) The cost of filing: the trouble of becoming informed about the UI system, the transaction costs of collecting benefits, and the psychological discomfort of being publicly supported.

2) The benefits of filing: the total amount of weekly UI payments over the expected duration of unemployment. This will be larger, the longer the worker expects to be unemployed.

The costs of filing will remain roughly constant over time, but the expected benefits will change with the tightness of the labor market and, hence, with economic indicators of the demand for labor. Thus, the fractions a_1 and a_2 can be taken to be functions of economic indicators.*

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*Variation in the fraction of laid off workers filing initial claims in recognized in the method for calculating unemployment (U.S. Dept. of Labor 1960).

Choosing linear functions and defining E_t as the relevant economic indicator,

$$a_1 = b_0 + b_1E_t \tag{5.4}$$

and

$$a_2 = b_2 + b_3E_{t-1}, \tag{5.5}$$

Substituting (5.4) and (5.5) into (5.3)

$$I_t = a_1b_0L_t + a_1b_1L_tE_t + a_2b_2L_{t-1} + a_2b_3L_{t-1}E_{t-1}. \tag{5.6}$$

5.4 Empirical Results

Two indicators were used as the variable E_t and each was found to have an independent influence over the decision to file for UI. The variables are the same as the ones used in the insured unemployment equation; the SMSA rate of accessions and the SMSA unemployment rate.[*]

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*This does not mean the worker studies these statistics to forecast how long he will be unemployed; the worker has more direct information in the form of whether he has job leads, whether his acquaintances are being laid off or hired, etc. The specification assumes only that the economic indicator E_t is correlated with the personal information of the worker.

The estimated equation is of the form

$$I_t = \text{monthly dummies} + a_1 L_t + a_2 L_t A_t + a_3 L_t u_t$$
$$+ a_4 L_{t-1} + a_5 L_{t-1} A_{t-1} + a_6 L_{t-1} u_{t-1}. \qquad (5.7)$$

The variable L_t represents a problem for the estimation, since layoff rates are not readily available for the non-manufacturing sector of the SMSA. Hence, it is necessary to assume that layoff rates in the non-manufacturing sector are equal to layoff rates in the manufacturing sector. Then the number of layoffs is equal to the layoff rate in manufacturing multiplied by total employment. The specification will be fairly accurate if layoff rates in the two sectors are highly correlated, except for seasonal differences, which are accounted for by the monthly dummies.

Estimates of the coefficients appear below:[**]

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[*] Again the method of calculating the unemployment rate leads to some circularity; it would be preferable not to use the unemployment rate in this equation. See section 2.2. However, given the fact that the unemployment rate must be included in the equation and the fact that the only available estimate of the unemployment rate is calculated from UI claims, it is better to include u as an indirect factor than as a direct factor. The specified equation is driven by layoffs, and the unemployment rate enters only indirectly to influence the transition rate between layoffs and initial claims. This is superior to using the unemployment rate to determine initial claims, though some correlation unavoidably remains.

[**] The estimated standard errors of the parameters appear in parentheses below the estimated parameters of all the linear equations.

$$I_t = \text{monthly dummies} + \underset{(.133)}{0.209L_t} - \underset{(0.018)}{0.108L_tA_t} \qquad (5.8)$$

$$+ \underset{(0.018)}{0.115L_tu_t} + \underset{(0.111)}{0.656L_{t-1}} - \underset{(.023)}{0.080L_{t-1}A_{t-1}}$$

R-SQR = 0.94

The statistical fit of the equation is close, though it would be much closer if non-manufacturing layoff data were available. This equation is identical to equation (5.5) except for the inclusion of monthly dummy variables and the exclusion of the term $L_{t-1}u_{t-1}$ because its coefficient is found to be insignificant. The other interaction terms are significant, indicating that the fraction of laid off workers filing initial claims for UI does indeed vary with the demand for labor. The signs on the interaction terms indicate the fraction of laid off workers filing a claim increases with an increase in the unemployment rate or with a fall in the rate of accessions. This coincides with our understanding of the laid off worker's decision to file an initial claim, since both an increase in the unemployment rate and a fall in the rate of accessions occur during a fall in the demand for labor. This fall in the demand for labor should, and does, cause an increase in the fraction of laid off workers who file initial claims.

To find the magnitude of this effect, the initial claims equation is summed over the two months we allow for initial claims to be made:

$$I = \text{monthly dummies} + 0.865L + 0.115Lu - 0.188LA \quad (5.9)$$

For mean values of the unemployment rate and the accessions rate the above equation implies the (marginal) fraction of laid off workers making initial claims is 0.73. Thus, if there are 100 extra layoffs there will be about 73 extra initial claims, during either the same month or the next month. But for each one percent increase in the unemployment rate there will be 12 more initial claims, and for each one percent increase in the rate of accessions there will be 19 fewer initial claims arising from the 100 layoffs. There is no independent source of data with which to compare these figures, but they appear plausible, both in direction and magnitude. The intuitive plausibility of the equation and its close statistical fit allow us some confidence in its ability to predict initial claims.

5.5 Number of Weeks Compensated

Not everyone who files a continued claim for UI, and is therefore defined as "insured unemployed," receives a UI payment. The claimant must serve one "waiting week" before he receives any payments, and he may be disqualified from benefits, either temporarily or permanently, for various enumerated offenses, such as refusing to accept suitable employment. These exceptions reduce the number of weeks actually compensated slightly below the number of insured unemployed. There is no strong reason to suspect that the gap between these two numbers varies cyclically, and the data suggest that it does not: regressions using cyclical variables such as the unemployment rate and the rate of accessions to explain the gap were ineffective. Yet a substantial variation exists since the simple regression of the dependent variable "number of weeks compensated" on the independent variable "insured unemployment," gives a coefficient of determination of only 0.86.

The explanation lies in the timing of claims and payments. A payment is recorded one or two weeks after the corresponding claim is made. A claim filed at the beginning of the current month will correspond to a payment in the same month, but a claim filed at the end of the current month will correspond to a payment in the next month. Payments recorded in the current month will correspond to claims in both the current and previous months. This leads to a moving average specification,

$$N_t = a_0 + a_1 IU_t + a_2 IU_{t-1}. \qquad (5.10)$$

where N_t = number of weeks compensated during month t.

In the actual estimation monthly dummy variables were included to reflect the different seasonal pattern of N as compared with that of IU.

$$\begin{array}{lll} N_t = \text{monthly dummies} & + \; 0.455 IU_t & + \; 0.354 IU_{t-1} \\ & \quad (0.0405) & \quad (0.0400) \end{array}$$

R-SQR = 0.975

The close fit of this equation, exemplified by the high coefficient of determination, and the small standard errors of the estimated parameters, provides empirical substantiation for the relationship formulated on a priori grounds. The estimated parameters show that 100 additional insured unemployed in one month will lead to about 46 additional UI payments in the same month and about 35 additional UI payments in the next month, leaving about 19 of the additional claimants to go without payments.

5.6 Total Amount of Benefits

During the sample years benefit rates ranged from $16 to $87 per week,[*] depending on the former wages of the insured worker and the number of his dependents. Dividing the beneficiaries into groups, the average benefit rate paid in Detroit is a weighted sum of the rates for different groups:

$$\frac{B}{N} = \sum_i R_i \frac{N_i}{N} \tag{5.11}$$

where R_i = the benefit rate for the ith group of beneficiaries

N_i = the number of beneficiaries in the ith group

N = the number of weeks compensated = $\sum_i N_i$

B = total amount of benefits (in dollars)

In order to evaluate the above expression we need some theory of the relationship between the weights, N_i/N, and the benefit rates, R_i. A complete analysis would be beyond the bounds of this study, but even a simple view of the components of insured unemployment is useful.

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[*] Since January 1, 1972, the maximum weekly benefit rate has been changed to $92.

When labor demand is high and insured unemployment is low we would expect to have a disproportionately large number of "disadvantaged" groups on the UI roles. This is because "disadvantaged" workers by definition are workers who have trouble finding employment, even when aggregate labor demand is high. As labor demand falls, progressively more employable workers are laid off and claim UI, so that the proportion of disadvantaged workers in the insured unemployment roles falls also. If we assume further that disadvantaged workers receive lower wages when they work and, conversely, that the more employable workers laid off during a cyclical downswing are likely to be higher wage workers, then the average wage paid to insured unemployed workers (prior to layoff) during a period of high labor demand will be less than during a period of low labor demand. Since higher previous wages will bring a worker higher UI payments we conclude that average UI benefit rates will be higher during periods of high unemployment.

Therefore the average benefit rate is assumed to be a linear function of the unemployment rate. The maximum weekly benefit amount is set by statute and fixed at any particular time. However, it is revised frequently by the Michigan Legislature in accordance with the level of the U.S. Department of Labor's Consumer Price Index (CPI). (Michigan, 1971, Section 27 (b-1)). Accordingly the weekly benefit amount is also taken to be a linear function of CPI:

$$\frac{B_t}{N_t} = a_1 + a_2 u_t + a_3 CPI_t \qquad (5.12)$$

Multiplying by N_t

$$B_t = a_1 N_t + a_2 N_t u_t + a_3 N_t CPI_t \qquad (5.13)$$

The above equation fits the data extremely closely, and all of its parameters are highly significant

$$\begin{array}{l} B_t = -331 + \underset{(.0046)}{0.\text{[illegible]}203N_t} + \underset{(.00023)}{0.00107N_t u_t} + \underset{(.000044)}{0.000268N_t CPI_t} \qquad (5.14) \\ \text{R-SQUARE} = 0.996 \end{array}$$

Dividing the above equation by N gives the average benefit rate for different levels of the independent variables. If we fix CPI and N at their means, the average benefit will be a function of the unemployment rate. To explore this dependence the average benefit rate has been calculated for three values of u: the mean of u, a value of u one standard deviation less than the mean, and a value of u one standard deviation more than the mean. Table 5.2 shows that the average benefit rate changes substantially over the business cycle and that the changes are in accord with the previous discussion. When there are few people on the UI roles these tend to be the low-wage, low-benefit rate individuals. But loose labor markets find higher-wage,

TABLE 5.2

AVERAGE WEEKLY BENEFIT RATE IN A CHANGING LABOR MARKET

Unemployment rate	Excess labor demand	Average weekly benefit rate	Approximate corresponding weekly income before layoff*
mean - standard deviation = 3.2%	high	$46.00	$80.00
mean = 5.5%	average	$52.55	$94.00
mean + standard deviation = 7.7%	low	$57.18	$103.00

---

*These are the weekly incomes which would yield the average weekly benefit rate in the column to the left. The average income of UI recipients is greater than this amount because of the ceilings on benefit rates and the payment of partial benefits.

higher-benefit rate individuals on the UI roles.

These calculations show that the parameters of the estimated equation are in agreement with *a priori* reasoning about the components of insured unemployment. Taken with the extremely close fit of the regression, they provide confidence in the equation as a forecasting tool.

CHAPTER VI

FORECASTING WITH THE COMPLETE UI MODEL

6.1 Forecasts Under the Existing System

Each of the equations of this model has been estimated and tested separately from the other equations of the system. It remains to test the entire system of equations, using the recursive feature in which forecasted values from previous equations are used as the independent variables for later equations, rather than the actual values of these variables. In this forecasting procedure the only observed values input to the system are the exogenous variables. All of the other variables are generated by equations.

For convenience a summary of equations is given in Table 6.1.

Four different sets of forecasts were generated corresponding to four different configurations of the model. The configurations differ in which variables were treated as exogenous and the time periods of the forecast. Table 6.2 describes the four configurations. The first configuration would be used by an analyst who has access to forecasts of employment and unemployment. For example, the Labor Market Information System model (1974) provides these variable levels. The second configuration would be used by an analyst

TABLE 6.1

SUMMARY OF EQUATIONS*

1) Layoff rate

$$L_t = \text{monthly dummies} + \sum_i a_i \Delta EM_{t-i} \qquad (6.1)$$

2) Accession rate

$$A_t = \text{monthly dummies} + \sum_i a_i \Delta EM_{t-i} \qquad (6.2)$$

3) Covered layoffs

$$LC_t \equiv EC_t \cdot L_t \qquad (6.3)$$

4) Initial Claims

$$I_t = \text{monthly dummies} + a_1 LC_t + a_2 LC_t A_t$$

$$+ a_3 LC_t u_t + a_4 LC_{t-1} + a_5 LC_{t-1} A_{t-1} \qquad (6.4)$$

5) Insured Unemployment

$$IU_t = \sum_{i=0}^{K} \delta_i \, b_{ti} \, I_{t-i} \qquad (6.5)$$

$$\text{where } b_{ti} \equiv \prod_{m=0}^{i} r_{t-m,i-m} \qquad (6.6)$$

$$\text{and } r_{ti} \equiv a_1 + a_2 e^{a_3 i} + a_4 e^{a_5 i} A_t/u_t$$

$$+ a_6 D_t \qquad (6.7)$$

6) Exhaustions

$$EX_t = \sum_{i=0}^{K} X_i \, b_{ti} \, I_{t-i} \qquad (6.8)$$

b_{ti} same as above

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*See Section 2.3 for a list of variables.

TABLE 6.1 (Concluded)

7) Number of Weeks Compensated

$$N_t = \text{monthly dummies} + a_1 IU_t + a_2 IU_{t-1} \qquad (6.9)$$

8) Amount of Benefits

$$B_t = a_0 + a_1 N_t + a_2 N_t u_t + a_3 N_t CPI_t \qquad (6.10)$$

TABLE 6.2

MODEL CONFIGURATIONS

Configuration	Exogenous Variables	Endogenous Variables	Eq. Used	Forecasting Method in Post-sample Period
1	EM EC u CPI	L A LC I IU EX N B	All	dynamic
2	L A u EC CPI	LC I IU EX N B	6.3 through 6.10	dynamic
3	I A u CPI	IU EX N B	6.4 through 6.10	dynamic
4	I A u CPI	IU EX N B	6.4 through 6.10	static

who has access to forecasts of labor turnover rates and unemployment rates. The covered employment variable need only be approximate. This configuration does not use equations (6.1) and (6.2) since the variables forecast by these equations are treated as exogenous. The third configuration treats the initial claims variable as well as the labor turnover variables as exogenous. This configuration is used to test a hypothesis described below about the effect of increased coverage provisions in the post-sample period.

In all of the configurations the forecasts over the sample period are computed one month at a time, that is, the current month is forecast from the equation system using the actual values of the variables in the earlier months. In the post-sample period, however, the use of actual data stops at the last month of the sample period. The endogenous variables are built upon each other, with each forecast becoming the predetermined variables of the next forecast. This corresponds to the viewpoint of an analyst in December 1971 trying to forecast the next five months consecutively.

The only exception to this post-sample procedure is in configuration 4, where the post-sample forecasts are generated one month at a time. That is, the same procedure is used in the post-sample period as is used in the sample period. Otherwise configuration 4 is the same as configuration 3.

Table 6.3 presents summary statistics from the forecasts of the four configurations of the model. Three statistics are reported.

1. "mean error/mean" is equal to the mean error of the forecast expressed as a fraction of the mean of the actual value of the variable. This statistic will indicate whether the system is consistently under or overestimating a variable. Since errors are predicted values subtracted from actual values a consistent underforecast will yield a positive (+) mean error and a consistent overforecast will yield a negative (-) mean error.
2. "RMSE" is equal to the root mean squared error of the forecasts.
3. "RMSE/mean" is equal to the RMSE mean squared error of the forecast expressed as a fraction of the mean of the actual value of the variable.

The above statistics are presented for each variable during both the sample period and a short post-sample period. The sample period is the 72 observations between January 1966 and December 1971, and the post-sample period is the 5 observations from January 1972 to May 1972. The post-sample period is too short to generate strong conclusions; however, it should be inspected because it is the only body of data presently available for testing the model.

TABLE 6.3

SUMMARY STATISTICS FOR FORECASTS

variable	$\frac{\text{mean error}}{\text{mean}}$ sample	$\frac{\text{mean error}}{\text{mean}}$ post-sample	RMSE sample	RMSE post-sample	RMSE/mean sample	RMSE/mean post-sample
			Configuration 1			
I	-.029	.380	792	12800	.267	.410
IU	-.014	.138	19700	52100	.118	.224
EX	.001	.375	391	2450	.188	.461
B	-.003	.141	714	2208	.100	.206
			Configuration 2			
I	-.037	.200	8290	7770	.251	.249
IU	-.040	.167	25200	44700	.151	.192
EX	-.021	.328	374	2370	.180	.441
B	-.016	.105	807	1560	.113	.146
			Configuration 3			
IU	.003	.078	16200	21400	.097	.092
EX	.008	.405	381	2530	.133	.475
B	.005	.029	697	955	.098	.089
			Configuration 4			
IU	.003	.005	16200	11000	.097	.047
EX	.008	.119	381	1176	.183	.221
B	.005	-.051	697	1082	.098	.101

More data could have been saved for testing the model, with the disadvantage that less data could then have been used for parameter estimation. This was thought to be undesirable for the purposes of this paper, because it would diminish the efficiency of the parameter estimators. Since some important applications of the model do not derive from forecasting, but from hypothesis testing, this was avoided.

6.2 Observations on Model Forecasts

1. All configurations perform fairly well during the sample period. For the crucial variables IU and B the RMSE is on the order of only 10% of the mean of the variables. The difficult variable EX is forecast with an RMSE of 18% of the variable mean. None of the equations shows any consistent proclivity to under or over-predict any of the variables over the sample period.

The forecasts of the various configurations are not strongly differentiated over the sample period. Surprisingly, Configuration 1 forecasts IU slightly better than Configuration 2 over the sample period, but the difference does not appear to be important.

2. Before considering the post-sample forecasts it is useful to describe some changes which were instituted in the Michigan UI system at the start of the post-sample period. The "1971 amendments" to the Michigan Employment Security

Act (Michigan 1971) affected a liberalization of the provisions of the UI system starting January 1, 1972, the first day of the post-sample period. The coverage of the UI system was expanded to include more workers, and the benefit rates were raised to increase weekly payments. The increase in benefit rates should not pose any problems for the model, since the model automatically adjusts weekly benefit rates to conform to the current level of the Consumer Price Index. However, the expansion in coverage will increase the number of initial claims resulting from given layoff rates, accession rates and unemployment rates (equation 6.4). This unforeseen increase in initial claims will carry over into increases in insured unemployment, exhaustions, payments, and benefits beyond the levels anticipated by the model.

Thus Configurations 1 and 2 underforecast initial claims in the post-sample period by 38% and 20% respectively. Resultant upon this outcome, IU is underforecast 14% and 17%, respectively, and benefits are underforecast 14% and 11%, respectively. RMSE's of forecast are better for Configuration 2, which has the advantage of exogenous labor turnover rates, than for Configuration 1, which must forecast its labor turnover rates. But even Configuration 2 has RMSE's of 19% and 15% for IU and B, respectively. These statistics should not be taken as indicative of errors, but as illustrative of the levels which would have been observed in the absence of the obvious structural change.

Section 6.4 discusses a systematic method for adjusting the model to reflect a structural change due to a revision in UI coverage. The method consists of increasing covered layoffs by the same fraction that covered employment is increased. For lack of an estimate of the increase in covered employment in 1972, this author has merely increased initial claims to the actual 1972 levels; that is, initial claims have been exogenized in Configuration 3.

The result is a gratifying improvement in the IU and B forecasts over the post-sample period. Underprediction falls to a meager 8% and 3%, respectively of IU and B, and RMSE falls to 9% for both variables. This strongly reinforces the idea of a structural shift in the post-sample period and puts the forecasts of IU and B within a useable range.

3. Exhaustions remain greatly underforecast in the post-sample period, even after initial claims have been exogenized. In Configuration 3, EX is still underforecast by 41% and RMSE remains 48%. It seems clear that something beyond the coverage change is raising actual exhaustions in the post-sample period. There were other minor changes in the UI law in 1971, however, none of these seems capable of increasing exhaustions substantially.

The most likely cause of the error lies in the assumption of constant values of X_i over time (Section 3.6).

These values will be constant over time in the real world only if the fraction of initial claimants receiving the various possible potential duration of benefits remains about the same over time. It will be recalled that potential durations are determined by the length of previous covered empolyment worked by the initial claimant up to the time of his layoff. This period of work will vary according to the condition of the labor market during the weeks previous to his layoff, causing potential durations to vary. If potential durations are below average, exhaustions will be unexpectedly high in succeeding weeks, and vice versa. This is a factor recognized in Chapter III but not included in the model because of inadequate data on potential durations (footnote, Section 3.6). If these data could be supplied, the exhaustions equation (and to a lesser extent the IU equation) could be improved by adding an equation to forecast X_i, rather than assuming it is constant over time.

The post-sample period is a clear example of the model underforecasting exhaustions due to sub-average potential durations. The post-sample period (early 1972) follows a year of high unemployment and unstable employment in Detroit. The unemployed workers filing initial claims in late 1971 or early 1972 worked fewer weeks during the previous year than they would during a period of normal labor market conditions. Hence they were given shorter potential durations, causing an unexpectedly large number of them to exhaust their benefits in early 1972.

In Configuration 3 the exhaustions equation will give correct average levels of exhaustions only if the forecasts are averaged over enough months that the variations in potential durations will even out. Thus the exhaustion equation may be relied upon to give average levels over the course of a year, but not to give accurate forecasts from month to month.

4. In an actual forecasting situation it may not be necessary at a single moment to forecast many periods into the future. It may be adequate to forecast the next period, and only next period to forecast the period after that. For example, the Michigan Employment Security Commission requisitions funds from the Treasury department for only a month at a time. It would be sufficient for MESC to predict next month's cash requirement in order to accomplish planning-programming-budgeting procedures.

In this case the previous values of the endogenous variables will be known at the time of forecast, and the amount of previous forecasting error will be known. These values can be used by the model to correct future forecasts on the basis of prediction errors in the recent past. This is due to the autocorrelated error terms of the IU and EX equations described in Appendices C and D. This error-adjustment capability of the model has been used in Configuration 4 to improve the forecast in the post-sample period.

The statistics show another substantial improvement.

Now IU and EX are only underforecast by 0.5% and 12%, and now B is overforecast by 5%. RMSE falls to only 5%, 22% and 10% of the means, respectively, of IU, EX and B. These are fairly accurate forecasts, post-sample predictions which are nearly as good as those made over the sample period. Figures 6.1, 6.2 and 6.3 diagram these predictions over both periods. Even the post-sample exhaustions forecasts track close to the actual values except for two months. In no case do the errors of the post-sample period seem unprecedented by comparison with those of the sample period. These findings instil some confidence that the equation system, with appropriate adjustments for structural shifts, can continue to produce accurate forecasts in the future.

6.3 Simulations of Alternative UI Provisions

This model is constructed to simulate the Michigan UI system* and the Detroit labor market. For example, the non-stationary Markov chain which results in the non-linear IU and EX equations is formulated to follow closely the progress of cohorts of unemployed workers as they file claims, get jobs or exhaust payments. This progress is governed partly by the labor market and partly by the rules of the UI system. These two inputs are carefully separated in the model so that each can be changed independently of the other. The previous section demonstrated how the model can forecast the

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*The UI provisions in force 1/66 through 12/71.

Figure 6.1 Insured Unemployment in Thousands of Continued Claims Per Month
Systems Forecasts: Configuration 4

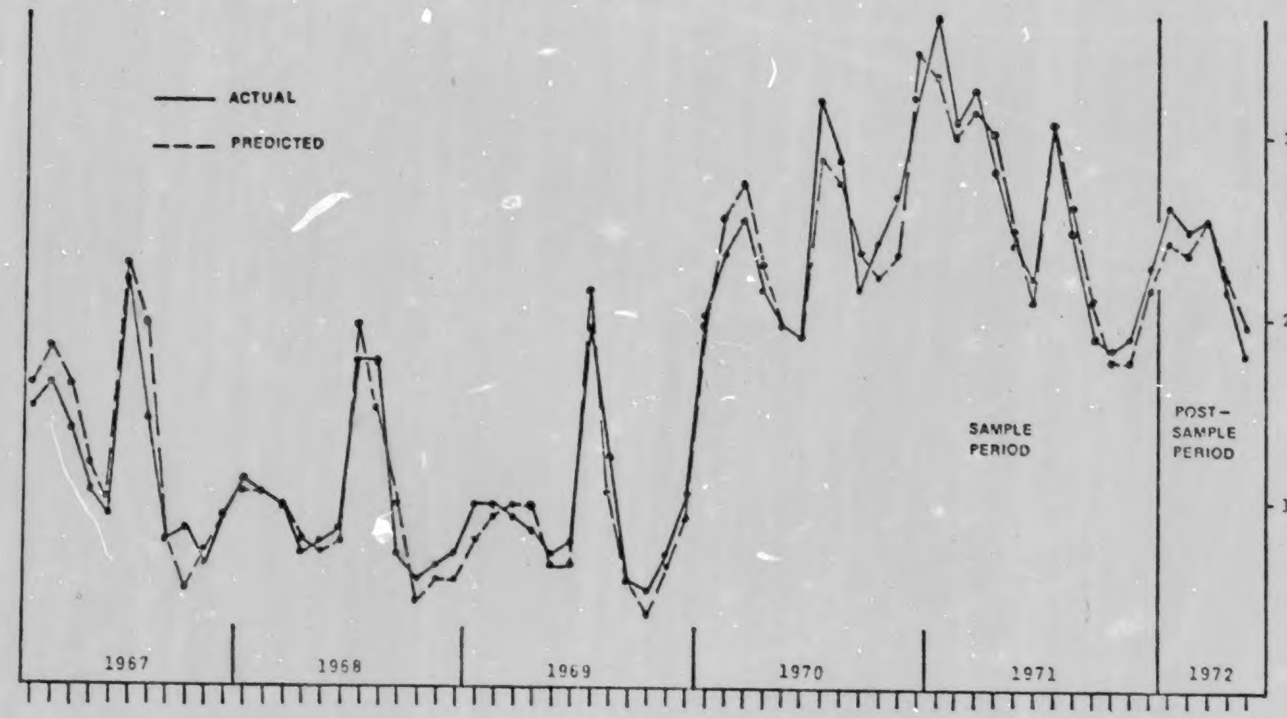


Figure 6.2 Unemployment Insurance Exhaustions in Thousands of Exhaustions Per Month
Systems Forecasts: Configuration 4

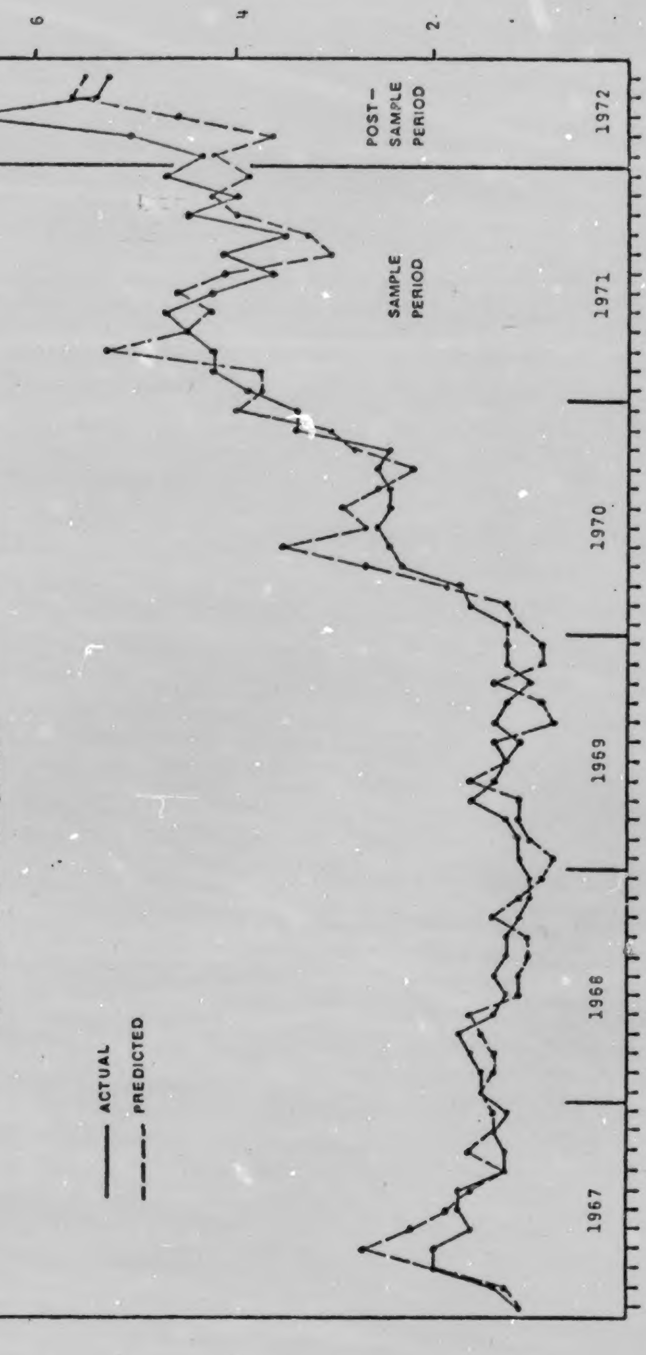
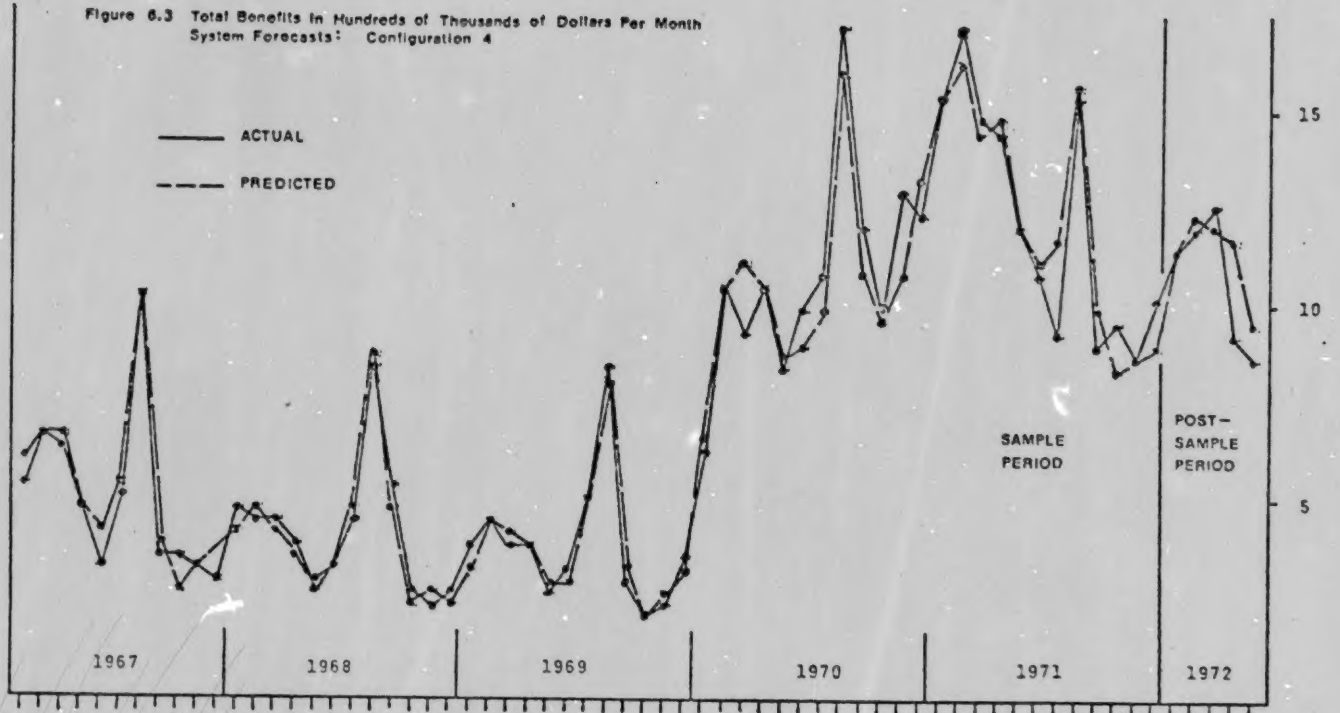


Figure 6.3 Total Benefits in Hundreds of Thousands of Dollars Per Month
System Forecasts: Configuration 4



existing UI system under new labor market conditions, in particular new layoff rates, accession rates, and unemployment rates applying in the post-sample period. This section describes a less common procedure: forecasting alternative UI systems under the same labor market conditions. This is a very valuable and practical application for it allows policy makers to simulate new UI provisions before they are enacted.

The exercise consists of five provisions which are not now in the UI system, but which could be enacted if the Michigan legislature so chose. Each of the provisions is simulated over one year and the resulting forecasts are compared with the forecasts for the unaltered UI system during the same year. The exogenous labor market variables are arbitrary, but the series of labor market variables recorded in 1971 were chosen for convenience and realism. The described changes in the UI system are meant to give concrete examples of the manipulation of the model, not to propose new policies or to predict the result of any actual amendment. Each proposal is studied in the absence of any other change; the following factors are impounded in ceteris paribus:

1. The other provisions of the Michigan UI system. Many changes could, of course, be combined in a single simulation but then the impact of each one separately would be obscured.

2. The exogenous variables which represent the labor market conditions.

3. The continuation rates estimated for the IU and EX equations. This amounts to the assumption that the minor changes depicted in the examples do not have so great an incentive effect upon unemployed workers that their rates of reemployment are substantially altered by the new UI provisions. This is a controversial and unresolved issue discussed in the next chapter. Evidence is presented there that the incentive effect is likely to be small for the existing UI provisions. If the incentive effect of the new UI provision is deemed to be large, equations can be added to the model to forecast continuation rates, rather than assume them unchanged.

6.4 Five Alternative Provisions

1. Coverage:

The original UI system of 1935 excluded many workers from UI by defining them outside of "covered employment." Partly this was the result of exaggerated forecasts of the cost of the system. Over the years these exclusions have been gradually eliminated, particularly in the amendments of 1970, which expanded coverage to include almost all of wage and salary employment. The definition of "covered employment" has been in constant flux and may continue to change.

The cost of providing greater coverage can be estimated by forecasting the increase in covered layoffs resulting from the provision of expanded coverage. Data on uncovered layoffs is not collected, so it is assumed that the rate of layoffs in the newly covered employment is the same as the rate of layoffs in manufacturing industries. Then the number of covered layoffs is estimated by the new total covered employment multiplied by the rate of layoffs in manufacturing. The entire new system can be simulated by substituting in equation (6.3) covered employment under the new provisions in place of covered employment under the old rules. The example simulates an expansion in coverage though it could just as easily simulate a contraction in coverage.

Suppose the UI system were enlarged to include self-employed workers. These workers have traditionally not been covered on the theory that their jobs are in their own hands. The theory does not always accord with reality and California has recognized this in covering some self-employed workers. If Michigan covered all of its self-employed workers the UI variables for Detroit would rise to the values presented in Table 6.4. On average, insured unemployment, exhaustions and the total amount of benefits paid would each rise about 7%.

2. Eliminating the waiting week:

The waiting week, which delays the payment of benefits to insured, unemployed workers, was instituted originally to provide time for administrative work in connection with the claim and to discourage claims. The administrative lag has diminished in importance and the discouragement has been criticized as contrary to the goals of the system. Seven states have eliminated the waiting week, including Michigan

TABLE 6.4

FORECASTS OF UI VARIABLES UNDER ALTERNATIVE PROVISIONS OF MICHIGAN UI LAW

SIMULATIONS FOR THE YEAR 1971

provision		Variable			
		IU Compensable Insured Unemployment	EX exhaustions	N number of weeks compensable	B amount of total benefits ($ Million)
existing provisions 1971	average*	273,938	4021	230,012	13.85
	ratio**	1.0	1.0	1.0	1.0
greater	average	292,923	4288	245,501	15.03
coverage	ratio	1.069	1.066	1.067	1.084
eliminate waiting week	average	286,191	4323	240,151	14.63
	ratio	1.045	1.075	1.044	1.056
One month waiting period	average	217,302	2981	181,975	10.35
	ratio	0.793	0.741	0.791	0.747

TABLE 6.4 (concluded)

provision		Variable			
		IU Compensable Insured Unemployment	EX exhaustions	N number of weeks compensable	B amount of total benefits ($ Million)
uniform potential duration	average	308,798	2537	257,652	15.94
	ratio	1.127	0.63	1.120	1.150
maximum duration 39 wks.	average	290,218	3314	243,152	14.85
	ratio	1.059	0.824	1.057	1.072

*The average of forecasts for the twelve months of 1971.

**The ratio of the average forecast under the alternative provision to the average forecast under the existing provisions.

as of February 10, 1974. No data are available to the author at this time on the impact of the change and so forecasts are made to estimate this.

The forecasts are made by (1) adding the number of waiting weeks to the number of compensable weeks to calculate compensable insured unemployment[*] and (2) adjusting the values of δ_i and X_i (Section 3.6) to reflect the fact that payments occur one week earlier with the elimination of the waiting week. For example, the 26th payment would be collected on the 26th week after initial claim instead of the 27th. It is only necessary to shift all of the values of δ_i and X_i one week ahead to do this:

$$X_i^* = X_{i-1} \qquad (6.11)$$

where the starred constants represent those that apply after the elimination of the waiting week. δ_i^* is recalculated according to equation (3.19). As shown in Table 6.4, making the first week compensable increases compensable insured unemployment by 4% and total benefits by 6%. However, the implicit one-week cut in potential durations of benefits has the negative effect of increasing exhaustions by about 8%.

3. One month waiting period:

Some researchers have sought to make UI available to longer-term unemployed without increasing the overall cost of the UI system. One proposal calls for extending the waiting period instead of eliminating it. This would make UI unavailable to short-term unemployed workers, but would make it available for a longer period to long-term unemployed (although the number of weeks compensated, even to a very long-term unemployed worker would not change). In effect the UI system would become a form of deductible insurance, the first part of unemployment becoming uninsured.

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[*] In these simulations the waiting period is being altered so it is necessary to distinguish between waiting and compensable insured unemployment. This was not necessary previously because compensable insured unemployment retained a fixed relationship to total insured unemployment.

It is possible that this uncompensable period would diminish some of the alleged work disincentive effects of UI, but the next chapter suggests the disincentive effect of UI is strongest in the later weeks of unemployment. Removing payments from the first part of unemployment and adding them to a later part will extend payments through a longer spell of unemployment and so might have a further disincentive effect. Again the constants χ_i and δ_i are adjusted to simulate the impact:

$$\chi_i^* = \chi_{i+3} \tag{6.12}$$

A four-week waiting period is found to have substantial effects on UI variables: compensable insured unemployment is cut by 21%, exhaustions are cut by 26% and total benefits are cut by 25%. The cut in exhaustions confirms the presumption that more individuals would be insured until they are able to find jobs.

4. Uniform potential duration:

One of the major controversies from the inception of UI concerns the basis on which to determine the potential duration of UI benefits. Most states, including Michigan, adhere to the premise that a worker "earns" his compensation by working in covered employment. In Michigan a worker earns three weeks of UI for every four weeks of covered employment he works. This has been criticized (Murray, 1974, p. 3) as providing the longest duration of benefits to those who need it least—those who have had the longest period of stable employment before being laid off. A few states provide uniform duration of benefits, regardless of previous employment to avoid this discrimination.

Suppose Michigan adopted this provision and established a 26-week potential duration for everyone qualified for UI benefits. The system response is simulated through changes in X_i and δ_i. X_i, the fraction of initial claimants with a potential duration of i weeks, would become zero except at i = 26 where it would become 1.

$$\begin{aligned} X_i &= 1 \text{ if } i = 26 \\ X_i &= 0 \text{ if } i \neq 26 \end{aligned} \qquad (6.13)$$

Substituting these values into the model we find insured unemployment would rise an average 13%, total payments would rise by 15% and exhaustions would fall by an impressive 37%.

Exhaustions would fall because anyone unemployed less than half a year would get a job before running out of benefits, whereas now a worker might exhaust benefits after 11 weeks of unemployment.

5. Extending the maximum duration of benefits:

It has been suggested that the present maximum duration of benefits (26 weeks) be extended so that fewer workers would exhaust their benefits. Extended benefits can now be collected until the 39th week of unemployment, but only during recession periods. Some states have made benefits beyond 26 weeks a part of their regular UI provisions.*

Suppose Michigan increases the maximum duration of its regular UI benefits from 26 weeks to 39 weeks. Assume that Michigan retains its present rule for determining potential durations: three weeks of benefits for four weeks of covered employment. The fraction of workers allowed potential durations of less than 26 weeks will remain the same. But the large group of workers with maximum durations of 26 weeks will be spread out over the interval from 26 weeks to 39 weeks. We assume the fraction of workers with potential durations in the interval between 26 and 38 weeks is the same as the fraction with potential durations in the interval between 11 and 25 weeks:

$$X_i^* = 0 \qquad i \leq 11$$

$$X_i^* = \alpha \;, \qquad 11 < i \leq 38 \tag{6.14}$$

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*However, post-exhaustion studies suggest there might be a work disincentive effect from longer benefits (Murray, 1974, pp. 16-26) and Chapter VII tends to reinforce the suggestion.

The fraction with maximum potential duration will be the remainder:

$$X_i^* = 1-28\alpha \qquad i = 39$$

Table 6.4 shows that insured unemployment increases by 6% and total benefits increase by 7%. An interesting conclusion is that exhaustions would fall 18%, a significant decrease but only half as large as the 37% decrease in exhaustions resulting from a uniform potential duration provision. Thus, if the legislators' goal is to reduce exhaustions the simulations show they have more powerful ways of achieving this than simply by increasing the maximum potential duration.

6.5 Further Simulations

The above examples show the power of the model in simulating alternative UI provisions and the potential usefulness of the simulations in determining policy. In a practical application of the model it may be desired to forecast the impact of new UI amendments during the years after they are enacted. This will require several simultaneous parameter modifications, rather than just one as above, and will require forecasts of future exogenous labor-market variables, rather than the past values which were used in the examples. This task can ordinarily be accomplished by repetition of the methods laid out above. For example, by 1975 UI coverage will be increased and the waiting week will have been eliminated. UI costs can be estimated by combining two of the above examples with forecasts of labor market variables for 1975. In this way the model can help achieve one of the most useful goals that economists have in government, namely to forecast the effects of a proposed policy before the public is stuck with it.

CHAPTER VII

THE IMPACT OF UNEMPLOYMENT INSURANCE ON AGGREGATE UNEMPLOYMENT

7.1 Introduction

The proposed Unemployment Insurance model, while developed primarily for forecasting, offers some insight into worker search behavior and the process of re-employment. The estimated continuation rates express an insured worker's probability of finding employment during a week of search and can be used to derive information about the duration of unemployment among insured unemployed workers. The information is useful in studying the impact of UI upon workers' motivation to return to work.

The chapter is presented as an example of how the estimated continuation rates, developed for projection purposes, can be applied to UI policy evaluation. The specific example offers tentative conclusions about the work disincentive effect of UI and suggests refinements in methodology which can be implemented where the primary goal of estimation is UI policy evaluation rather than projection.

7.2 Background of the Controversy

Several researchers have concluded that the aggregate

Phillips' curve offers little hope that the U.S. will be simultaneously able to achieve acceptably low rates of unemployment and inflation (Phillips 1958 and U.S. Congress 1972). Holt (1971, p. 36) asserts that even such historical successes as have been achieved in keeping both unemployment and inflation down, for example in 1955, 1965 and 1966, were inherently short-lived. The long-run inflation responses to the high demand of those years invariably pushed inflation rates beyond acceptable rates in subsequent years. The current unemployment and inflation rates are 5.2% and 8.2%, respectively.[*] The aggregate unemployment rate has averaged over 4.5% in the past 20 years.

The adverse tradeoff represented by these findings leaves little room for successful stabilization policy based solely on manipulation of aggregate demand. Indeed it would seem to imply a measure of failure in either the areas of price stability or unemployment or both. The frustration with this adverse tradeoff has been heightened by a feeling that some European countries have had a much more favorable tradeoff between unemployment and inflation.

These observations have led to an intensive search for structural factors in America which make the economy particularly prone to unemployment and inflation. It is hoped that the structure of the economy can be altered in combination with supportive aggregate demand policy to increase both employment and price stability simultaneously.

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[*] Unemployment rate is for the first quarter of 1974, seasonally adjusted (U.S. Dept. of Labor, 1974, Table 5, p. 93). The inflation rate is the increase in the CPI from April, 1973 to April, 1974, seasonally adjusted (U.S. Dept. of Labor, 1974, Table 25, p. 107).

Into this debate has been introduced the disturbing idea that the government itself promotes unemployment through the UI system. This, of course, is a very serious charge, since about 40-50%* of the unemployed nationally are insured. It does this, Professor Feldstein (U.S. Congress 1973) asserts, by subsidizing employers to expand seasonally variable employment and by subsidizing workers to extend the duration of their unemployment. The effect upon employers will not be examined here, though its possible importance is not denied.

7.3 The Incentive Effect of UI Payments Upon The Duration of Unemployment

Feldstein argues (1) that UI reduces and sometimes entirely eliminates a worker's cost of unemployment due to wage loss and (2) that workers substitute leisure and/or job search time for work at the reduced price by remaining unemployed longer than they would in the absence of UI.

Feldstein supports his thesis that UI substantially reduces the cost of unemployment with an example of a hypothetical Boston family of four. In the example weekly UI payments amount to 80% of the husband's previous wages net of taxes.

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*The fraction changes cyclically. (Green, 1971)

He further cites examples where the weekly benefit rate is 100% or more of the net wage. The U.S. UI Service (Dahm, 1974) has studied Feldstein's examples and would prefer to revise downwards these estimates. It finds that the examples are of an atypical family, in an atypical state and may be incorrectly calculated. But even the UI Service finds benefit rates in the range of 60% to 70% of net wages.

The question remains whether this payment does in fact induce an alteration in workers' job search. Feldstein frankly admits that almost no empirical study has been devoted to this critically important question. He cites a study by Chapin (1971) which shows that mean durations of benefits are longer in states with more ample UI benefits. However, his dependent variable is insured duration, rather than total duration of unemployment. Chapin's finding must be viewed with extreme caution in view of the strong tendency of the State UI formulas to be liberal in maximum weeks of benefits if liberal in maximum weekly amounts. (U.S. Dept of Labor, 1972). Thus the states with less ample UI benefits may merely substitute uninsured unemployment for insured unemployment without decreasing total unemployment.

Feldstein's other evidence is questionable. He compares the 14.2 average weeks of benefits drawn per beneficiary in fiscal year 1971 with the BLS average duration of unemployment of 10.1 weeks, claiming that the difference is due to the disincentive effect of UI. However, the two figures are not comparable because the UI figure represents the amount of insured unemployment during an entire year, while the BLS figure represents the average number of consecutive weeks of unemployment to that point experienced by workers unemployed in the survey week. Thus the UI figure refers to weeks of unemployment during a year, and the BLS figure refers to weeks of unemployment during a single spell of unemployment. The UI figure for the average duration of a spell of unemployment was 7.0 weeks in 1971. However it would still be inappropriate to compare the 7.0 week figure for insured unemployed with the 10.1 week average duration of unemployment for all unemployed. In order to see why we must clarify the definition of unemployment duration.

7.4 A Digression on "The Average Duration of Unemployment

Kaitz (1970) has pointed out two distinct ways of looking at the unemployed by duration:

(1) A cross-section "snapshot" of all workers currently unemployed, measuring the length of each unemployment spell up to its current duration, whether it is completed or not. The monthly average of these numbers is the "average duration of unemployment" published by BLS each month and referred to as 10.1 weeks in 1971.

(2) A longitudinal view which measures the duration of unemployment at the completion of each spell. These durations are not observed directly, but can be estimated statistically from CPS. Kaitz estimates that the average duration of completed spells of

unemployment in 1969 was 4.6 weeks, much shorter than the BLS average duration of unemployment. Following these definitions the average duration of a spell of insured unemployment should be compared with the average duration of completed spells of unemployment. Thus the average duration of 5.5 weeks for insured unemployed in 1969 should be compared to the average duration of 4.6 weeks for all unemployed.*

These average durations of unemployment, both total and insured, are much shorter than Feldstein imagines. It is much easier to picture the insured unemployed as delaying their re-employment if they average 14 weeks of unemployment -- as Fedlstein believes -- rather than 5.5 to 7.0 weeks -- as is more accurate. Still, insured workers do seem to remain unemployed slightly longer than do unemployed workers as a whole -- about a week more on average. Whether this small difference represents a disincentive effect will be investigated further.

7.5 Summary of Current Evidence About UI Impact

Other evidence must be classified as purely anecdotal. For example, the rise in the unemployment rate in England after it adopted a wage-based unemployment insurance act is not shown to be causally related. On balance the casual empiricism of both Feldstein and his detractors is inconclusive.

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*The average duration of unemployment according to definition (1) is always much larger than the average according to definition (2), because definition (1) "oversamples" the long-term unemployed. For example a spell of two weeks is twice as likely to be included in the sample as a spell of one week. Similarly any random sample of all currently unemployed workers will include a disproportionately large number of long-term unemployed. However if only completed spells are sampled, there will be one observation for each spell, and the proportion of spells of a given duration will be the same as the proportion among all spells.

Nor is the theoretical case any stronger. Feldstein assumes the substitution effect of UI decreases work time by extending the duration of unemployment. But the temporary nature of UI and the negative social stigma of public support may substantially reduce the substitution. Furthermore administrative safeguards require the UI recipient to continue active job search and not refuse "suitable" employment. (Michigan, 1972). Whether these requirements are successful in preventing delay is unknown. The current theory of job search is not much help in these matters, due to its rudimentary state of development.

It seems likely that UI increases unemployment duration, but the magnitude of the increase is still unknown.

It is not a foregone conclusion that the effect of UI in increasing the average duration of unemployment is necessarily undesirable. The loss of manpower through unemployment might be considered negligible by comparison with the possible improvement in labor productivity resulting from further job search and better job matches.

7.6 Comparison of Insured with Total Continuation Rates

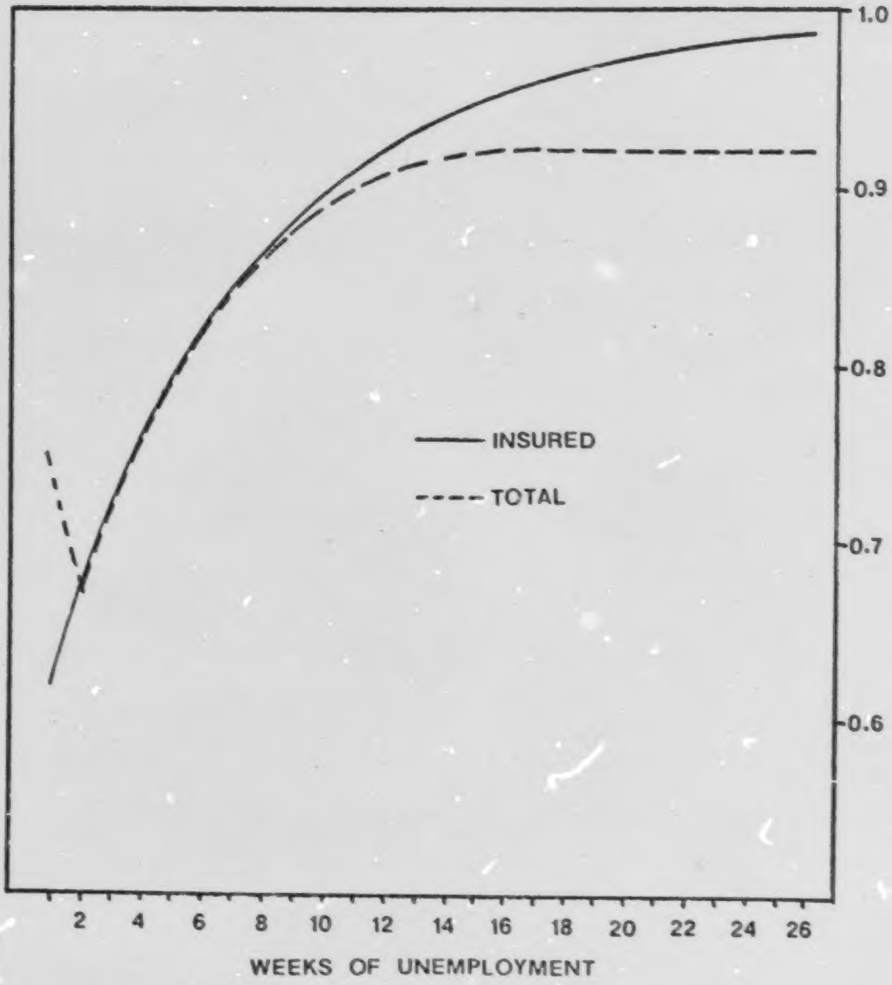
If UI has a substantial work disincentive effect it must cause the insured unemployed to be re-employed more slowly than the uninsured unemployed. One way to make a quantitative assessment of the impact of UI in America is to compare the re-employment rates of the insured unemployed with the re-employment rates of the unemployed as a whole. This can be done by comparing the continuation rates calculated in Chapter IV from UI data with the continuation rates calculated by Kaitz (1970) from Current Population Survey data covering all unemployed. Of course these data sets and continuation rates were not designed for comparison with each other, so it is necessary to make allowances for the more gross inconsistencies between them.

Kaitz has estimated continuation rates which apply to all unemployed in the United States during 1969. The continuation rates calculated from the insured unemployment equation (3.20) represent continuation rates for insured unemployed in Detroit for the period 1966-1971. It would be most convenient if the two groups were identical except that one group included all unemployed and the other included only insured unemployed. Unfortunately, the two estimates are different in other ways as well. Two obvious differences exist: (1) There are different levels of demand and supply for labor in the two samples. The U.S. unemployment rate in 1969 was only 3.5%, but over the sample period Detroit averaged 5.0% unemployment. This difference indicates that the average duration of unemployment for all workers is longer in Detroit than it is in the country as a whole. We would like the average duration of unemployment for all workers to be the same in both groups, so we could focus on the difference in average duration between insured workers and uninsured workers. Accordingly we would like to standardize the two samples so that they have the same aggregate labor demand as represented in the rate of unemployment and the rate of job accessions. (2) There is an annual layoff of workers in the auto industry of Detroit during "model changeover." This layoff injects an atypical group of insured unemployed workers into Detroit's labor market every July. The influence of these two factors in Detroit has been carefully examined in Chapter IV, so it is possible to adjust the insured continuation rates to eliminate the difference between the insured and total continuation rates with respect to these two factors. Since both of these factors appear as independent variables in the insured continuation rate equation, it is merely necessary to substitute the proper levels of these variables. In effect we create the schedule of insured continuation rates which would have existed with an unemployment rate of 3.5%, an accession rate of 4.7% and without a "model changeover." These are the conditions which existed in the nation as a whole in 1969.

Figure 7.1 presents the resulting insured and total continuation rates in graphical form. Three aspects of this figure are noteworthy:

(1) The two curves are very similar in shape, and they are not widely separated from each other. There is

Figure 7.1 Comparison of Insured and Total Continuation Rates



far more variation in rates within each curve than there is difference in rates between them. The insured curve is neither completely above nor completely below the total curve.

If UI had a very strong work disincentive effect insured unemployed workers would delay their return to work as compared with uninsured unemployed workers. A smaller percentage of insured unemployed workers would take jobs each week than would uninsured unemployed workers. Thus the insured re-employment rates would be less than the uninsured re-employment rates and the insured continuation rates would be more than the uninsured continuation rates. Similarly the total continuation rate curve would lie below the insured continuation rate curve. We do not observe such an extreme in Figure 7.1, at least not along the full length of the curve. Therefore, it would be surprising if we found that what differences do exist argued persuasively for a strong disincentive effect from UI. Basically we observe that re-employment rates for insured unemployed are not far different from re-employment rates for all unemployed. Certainly if the average duration of unemployment were more than 50% longer among the insured than the uninsured, as Professor Feldstein (U.S. Congress 1973) testifies, then the insured continuation rate curve would be well above the total continuation rate curve. Instead the insured curve and the total curve very nearly coincide over the domain starting at the second week of unemployment and ending about the tenth week of unemployment.

(2) Except for the first week of unemployment the insured curve is above the total curve or coincident with it. This is interpreted to mean that (except for the first week) the insured unemployed return to employment at a rate less than or equal to that of the uninsured unemployed.

The only exception to this rule in the first week may be caused by (a) the different functional forms fitted to the data to provide the two different estimates or (b) the different composition of the insured as opposed to the uninsured unemployed.

(a) The exponential form chosen for the insured continuation rates requires that the continuation rates be monotonically increasing or decreasing and allows no sudden jumps in the continuation rates.

(b) The insured unemployed are primarily workers who have been laid off from their jobs. This of course is the main group which UI is designed to protect. Some of these workers are on short fixed-term layoffs and are recalled to their jobs within a few weeks. Thus the fraction of insured unemployed workers re-employed the first week may be high simply because a certain fraction of them complete their short layoff period. This is a factor which is associated with UI, but not caused by UI and could confuse the analysis of UI incentives.

Rather than develop an elaborate procedure to statistically adjust the figures for the unwanted factor* the author has simply attempted to put limits around the proper adjustment. The upper limit of the insured continuation rate at week one corresponds to the assumption that all of the difference in re-employment in that week is due to short-term layoffs and the lower limit of the insured continuation rate at week one corresponds to the assumption that none of the difference in re-employment in that week is due to short-term layoffs. Thus in week one the insured continuation rate may be anywhere between the estimated insured rate and the estimated total rate.

(3) The most likely explanation for the rise of insured continuation rates above total continuation rates after week ten is that the uninsured unemployed take jobs at a faster rate than the insured unemployed because they have more incentive to find jobs. The gap between the two curves is significant in the sense that it exceeds the estimated standard error of the insured continuation rate.** The short-term laid-off workers are no longer unemployed in this range of relatively long unemployment spells, so we don't have to be concerned about special biases from that group.

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*An extended statistical adjustment of this sort, not only for this factor but for demographic differences between the two groups, is beyond the goal of this chapter, which is only to provide an example of the application of continuation rate analysis to UI incentive effects.

**No standard error is available for the total continuation rates calculated by Kaitz (1970).

Two other explanations for the gap have been eliminated by proper adjustment of the curves. Further confounding difference may exist to alternatively explain the gap; these would include whatever socio-economic differences exist between the two samples or any differences in labor-force participation between the two samples. These cannot be evaluated within the confines of the available data. It seems unlikely that any of them would be as pronounced as the fundamental difference between the samples: one group is insured, and the other is not insured, and an incentive difference results.

It is interesting that this gap only arises for fairly long-term unemployed workers. This indicates that short and medium-term unemployed workers are not influenced as much by UI incentive effects as are long-term unemployed. Possibly long-term unemployed insured workers decrease their job search activity below that of the uninsured workers only after several weeks of unsuccessful search. Insured unemployed workers have the luxury of being able to decrease their job search activity when discouraged and still have some income.

7.7 The Aggregate Effect of UI Disincentives

It is possible to determine the macro-economic effect of these re-employment rates using the curves we have estimated.

Assume all variables are constant over the year we are studying. Then equations (3.7) and (3.20) can be written in a steady-state form:

$$b_i = \prod_{m=0}^{i} r_{i-m} \tag{7.1}$$ [*]

and

$$U = \left(\sum_{i=0}^{\infty} b_i \right) I \, . \tag{7.2}$$

Then the average duration of unemployment is given by

$$D = \frac{U}{I} = \sum_{i=0}^{\infty} b_i = \sum_{i=0}^{\infty} \prod_{m=0}^{i} r_{i-m} \tag{7.3}$$

This is the average of completed spells described in Section 7.4, not the published BLS average, which is inappropriate here. Equation (7.3) shows that it is calculable directly from continuation rates (r). Since we have continuation rates for insured and total unemployed we can calculate insured average duration and total average duration, D^I and D^T. D^U, the uninsured average duration, is calculated as

$$D^U = \frac{D^I D^T - SD^I D^T}{D^I - SD^T} \, , \tag{7.4}$$ [**]

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[*] I = the number of spells of unemployment initiated per week.

r_i = continuation rate (conditional probability of remaining unemployed in current week, given i weeks of unemployment).

b_i = the probability of being unemployed i weeks.

U = level of unemployment in workers per week.

Where S is the fraction of unemployed workers who are insured. In 1969 this fraction was 38.8% (Green. 1971). Table 7.1 gives values for average duration of unemployment calculated from (7.3) and (7.4). The continuation rates used to calculate the average duration of insured unemployment are the insured rates up to the maximum 26 weeks and the uninsured rates after 26 weeks, when benefits have been exhausted. The duration for uninsured workers has a lower range than for insured workers, but they are equal at the upper limit of uninsured duration and the lower limit of insured duration. The apparent conclusion from this table is that insured duration may be a little longer than uninsured duration, but not very much.

What would be the unemployment rate if no UI system existed? To answer this question we assume that without UI, all unemployed workers, including the present insured unemployed, would have the average duration of the present uninsured unemployed. The average duration of total unemployment would become the present uninsured duration instead of the present total duration. Assuming the number of spells of unemployment remains unchanged, the level of unemployment would decrease in the same proportion as does the

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**Solve simultaneously

$$I^I + I^U = I^T$$

$$U^I + U^U = U^T$$

$$U^I / U^T = S$$

and the definitions of the three average durations from equation (7.3).

TABLE 7.1

THE AVERAGE DURATION OF UNEMPLOYMENT FOR DIFFERENT GROUPS IN 1969

(weeks)

Unemployed Group	Lower Limit	Upper Limit
Insured Unemployed (Existing System)	4.6	5.4
Uninsured Unemployed	4.2	4.6
Total Unemployed	4.6	4.6
Insured with 39 Weeks Maximum Potential Benefit Duration	5.0	5.9
Insured with 52 Weeks Maximum Potential Benefit Duration	5.4	6.5

average duration of total unemployment. The average duration of unemployment may not fall to this level if aggregate labor demand is insufficient to absorb the increased offering of labor without UI. Since the analysis is performed for the year of greatest aggregate labor demand in recent U.S. history, this should not present a problem in the computations performed here. The results appear in Table 7.2.

In 1969 the national unemployment rate might have been as low as 3.2% instead of the actual 3.5%. This 0.3% is much smaller than the 0.8% difference which Professor Feldstein calculates or the 1.5% calculated by Green (1973). Furthermore the lower bound of the average duration of insured unemployment is no more than the average duration of uninsured unemployment. Considering the assumptions upon which the bounds are established, this is unlikely. However this extreme allows the possibility that no part of the unemployment rate is due to unemployment insurance.

These findings suggest that the existing unemployment insurance system, while it probably causes some unemployment, is not a major foundation of structural unemployment. This would contradict other studies of UI, but would be more in line with the estimates of average duration of unemployment in Section 7.4.

7.8 Incentive Effects of New, More Generous UI Systems

What would be the unemployment rate in a new UI system in which every unemployment spell were insured rather than

TABLE 7.2

AGGREGATE U.S. UNEMPLOYMENT RATES FOR 1969 UNDER ALTERNATIVE UI SYSTEMS

Proportion of Unemployment Spells Insured Type of UI System	Existing Proportion of Spells Insured (About 40%)		All Spells Insured (100%)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
No UI	3.2	3.5	3.2	3.5
Existing UI System (26 weeks max.)	3.5	3.5	3.5	4.0
39 Week Maximum Potential Duration	3.6	3.6	3.8	4.5
52 Week Maximum Potential Duration	3.8	3.8	4.1	4.9

the present 39% of spells? Assuming the present average duration of insured unemployment would become the new average duration of all spells of unemployment, the unemployment rate in 1969 could have been as high as 4.0%. This is a fairly significant increase over the actual 3.5% unemployment rate and over the 3.2% which would have existed without any UI.

Now suppose we consider a new UI system in which the maximum potential duration of benefits is increased from 26 weeks to 39 weeks or 52 weeks. Such increases have been proposed by advocates of more liberal subsidies.

This new system could increase the aggregate unemployment rate through further increases in the average duration of unemployment. To estimate the rise in unemployment we assume the insured continuation rates can be extrapolated beyond 26 weeks to the new maximum potential duration using the functional form estimated over the 26 weeks. We assume that the insured continuation rate, rather than dropping back to the uninsured continuation rate after 26 weeks, remains at the insured continuation rate through the maximum potential benefit duration. In other words we assume that the insured re-employment rate does not increase to the uninsured re-employment rate after 26 weeks, but remains at the lower insured rate until 39 or 52 weeks.

Table 7.2 presents the results. Under a 39-week UI system the average duration of insured unemployment may increase to 5.9 weeks. If the present proportion of spells of unemployment were insured this would raise the total unemployment rate to 3.6%.[*] If all spells of unemployment were insured the unemployment rate could rise to 4.5%.

Similarly, for a 52-week UI system the average duration of insured unemployment may increase to 6.5 weeks, raising the unemployment rate to 3.8% if the present proportion of unemployment spells are insured and to 4.9% if all unemployment is insured.

For these extended UI systems, even the lower bounds of the average duration of insured unemployment and the resulting unemployment rates are greater than the corresponding figures for either a no-UI system or the existing system. It seems fairly certain that any of these extended UI systems would increase the duration of insured unemployment and consequently the unemployment rate itself. In the extreme case, the 3.5% actual unemployment rate in 1969, one of the lowest post-war rates, could be transformed into a mediocre 4.9%, if a 52-week UI system covering all unemployment spells were instituted.

7.9 Conclusion

This chapter is presented as an example of the application of the proposed UI model and should not be taken as a final statement on the impact of UI incentives. It relies upon existing estimates of total continuation rates and it does not allow for all possible "confounding" differences between the sample of insured and uninsured unemployed workers.

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[*] $U^+ = \left[S\frac{D^+}{D^I} + (1 - S)\right] U^T$ where U^+ and D^+ are the unemployment rate and average duration of insured unemployment for the extended UI system. D^+ is calculated from equation (7.3) under the new assumptions about continuation rates.

Nevertheless it provides a systematic study of one of the most crucial issues in manpower economics, the extent to which the government creates unemployment through the UI system. It particularly emphasizes the meaning of "average duration of unemployment," a concept which has been misused in previous studies, and provides a method for calculating it from administrative data bases. The average duration of unemployment for insured workers is found to be only slightly longer than for uninsured workers.

The implications for UI policy are fairly clear: neither the boosters of UI, who deny any disincentive effect from UI, nor the attackers of UI, who blame UI for a large amount of unemployment, were found persuasive. Instead the existing UI system was found to cause a small, but perceptible amount of unemployment in the U.S., as much as 0.3% of the labor force. It would not be surprising if the advocates of UI could justify this small cost in terms of income redistribution and more efficient job-matches resulting from increased search time.* It is not a figure which brings to mind armies of unemployed malingerers and UI chiselers.

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*Of course they should now come forward with empirical evidence on these points.

The implications for expanded UI systems are more severe. The extended programs considered, including longer maximum potential benefit durations and wider coverage provisions, were found to substantially increase the duration of insured unemployment and, consequently, the unemployment rate. These findings should signal caution against major expansions of the UI system.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

8.1 Forecasting UI Activity and Benefits

This paper presents an econometric model of the unemployment insurance system in Michigan applied to data from the Detroit SMSA. The equations which comprise the model have been specified in accordance with the Michigan UI system and economic theory. They have been estimated with optimal econometric techniques and practical administrative UI data. The model has been tested for its predictive power, both during and after the sample period. It has been shown to provide accurate forecasts of UI variables, particularly if adjustments are incorporated to allow for amendments to the UI system.

In an actual forecasting situation it will be necessary to provide the model with estimates of the exogenous labor market variables in future time periods. Because this paper deals with the relationship between the labor market and the UI system, and not with the labor market itself, it does not provide those forecasts. It does, however, facilitate their generation by offering a choice among alternative sets of acceptable exogenous variables. Each of these sets creates a new configuration of the model and each configuration has been carefully documented and tested for its forecasting ability.

The uniqueness of this model lies in the view it takes of the labor market in modeling insured unemployment. It goes behind the stock of unemployed workers to look at the transitions of workers to and from employment and in and out of the UI system. This "labor turnover" view of the labor market is shown to be successful in explaining insured unemployment and UI benefit exhaustions and also to describe the process of job acquisition as a function of the duration of unemployment.

8.2 A Non-stationary Markov Chain

The model consists of seven interdependent statistical equations which transform labor market variables into unemployment insurance outcome variables. Two of the equations of the model represent a new econometric application developed specially to predict insured unemployment, but applicable to a large class of stock-flow problems in economics. The stock of insured unemployed workers is fed by the flow of workers who are laid-off from their jobs and emptied by the flow of such workers who find jobs or exhaust their benefits. This flow is compared to the statistical process known as a Markov chain. The origin state of the chain is the state of being insured and unemployed, and the possible transitions each week are (1) remaining in the insured unemployed state, (2) finding a job or (3) exhausting UI benefits before finding a job. The contribution of this application is to specify the transition probabilities between the origin and destination states as non-stationary and to derive from this specification a parametric model where the parameters can be estimated by least squares. This is more realistic than a traditional stationary model because a worker's chance of finding a job depends (at least) upon the demand for labor and the length of time he has been unemployed. A stationary model would predict poorly because it assumes this transition probability is invariant over time.

The mathematical form of the derived relationship turns out to be a distributed lag model where the lag weights are not parameters but are functions of the exogenous demand for labor services. The method uses a priori information to minimize the number of parameters which must be estimated from the data. Standard distributed lag models, such as those of Almon, Koyck or Jorgenson make inappropriate assumptions about the lag weights and are incapable of incorporating the special interactions between the flow variables and the demand for labor. Other variable-weight distributed lag models (Popkin 1965 and Tinsley 1967) also do not incorporate the special relationships which derive from the operation of a Markov process. For example the Tinsley method specifies the lag weights as linear functions of an independent variable, whereas this paper shows that a non-stationary Markov chain generates distributed lag weights which are multiplicative functions of an independent variable (equations 6.5, 6.6 and 6.7).

The method is not confined to the labor market but applies in many situations where it is desired to express a stock variable as a function of the flows into it, and the flows out of it vary in a known way over time.

For example the stock of a grain inventory is generated by the harvest of the grain, but the amount remaining at any time is diminished by the amount sold and the amount which rots. The probability that a bushel of grain inventory this week will remain on inventory next week is not constant over time but is determined by the demand for grain and the length of time it has been on the shelf. Analogous to the above method the stock of grain inventory can be written as a distributed lag on the harvest of the grain. The lag weights are determined by the demand for grain and a few parameters which can be estimated by least squares.

8.3 Labor Market Information

The labor market transition rates which fall out of this analysis are useful quantities in themselves. In particular, the continuation rate, which expresses an insured unemployed worker's chance of remaining unemployed, has been examined for its implications about job search.

A picture of heterogeneous job-searchers emerges from the data. Some workers find jobs easily or return to their previous employment after a short, temporary layoff. But the chances of finding a job diminish rapidly the longer a worker is unemployed. A worker unemployed 20 weeks has only about a quarter of the chance a worker unemployed 10 weeks has of getting a job during the next week. Part of this is explained by the inherent heterogeneity of the labor force, part of it by the incapacitating effects of long unemployment on the worker himself, and part of it by the counter-incentive effects of UI towards work.

The incentive effect of UI in job search has been the subject of an independent application of the estimated continuation rates. The issue studied is whether UI subsidizes unemployed workers to remain unemployed longer than they would in the absence of UI. If so this could lead to an increase in the unemployment rate and to the waste of labor resources.*

This study compares the continuation rates estimated for insured unemployed workers with continuation rates estimated elsewhere for the unemployed as a whole. The comparison shows a margin between the two for workers unemployed longer than about ten weeks: after this time insured unemployed workers have very little chance of accepting a job, but uninsured unemployed workers are still finding jobs at the rate of about 8% per week. This leads to a small increase in the average duration of unemployment of insured workers over uninsured workers, as is claimed by the critics of UI. However, the difference is found to cause an increase in the unemployment rate of only about 0.3%[*] nationally, much less than is sometimes claimed. Based upon this evidence it would appear that the modern critics of UI have a genuine issue, but are exaggerating its importance.

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*An increase in the duration of unemployment does not necessarily lead to labor waste, because the additional time might be used for socially valuable job search and might result in improved labor productivity. This is a further unresolved issue. Still, the prior issue is whether any unemployment increase is caused.

Further calculations suggest that certain revisions of the UI system such as extension of the maximum duration of UI benefits and expansion of its coverage could have a more substantial counter-incentive effect towards work, adding as much as 1.7% to a 3.2% unemployment rate. It would appear that the current criticism of UI should be directed more toward further liberalization of the UI system, than toward the present UI system.

8.4 Policy Revision and Analysis

Because of its independent treatment of the processes of moving in and out of unemployment and of moving in and out of the UI system, the present model is capable of forecasting UI variables for not only the present UI system, but a wide variety of alternative UI systems which could be created by amendment of the provisions of the Michigan Employment Security Act. Alternative systems can be simulated by merely changing the values of a few constants in the model. The constants are presently set at values applicable to the sample period of this study, 1966 to 1971. Several examples are given to show how the model can be modified to incorporate amendments. This capability of the model has two major benefits: (1) It improves forecasts and (2) it allows analysis of hypothetical UI provisions.

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[*] During the low unemployment year 1969.

Forecasting UI benefits is like shooting at a moving target: the UI system has recently been amended nearly every year, and these amendments change total benefit amounts even if employment, unemployment and labor turnover remain constant. Recent amendments have altered the coverage of the UI system, the length of the waiting week and the maximum amount of benefits. If a forecast is made on the basis of previous UI provisions it is likely to be in error. For example, the 1971 amendments to the Michigan Employment Security Act increased the cost of UI benefits by about 19%.

Therefore, it is necessary to be able to quantify the administrative changes and substitute them into the model. Only then can the forecast be based upon the UI provisions which will apply during the forecast period. The present model allows a wide range of modification, a range which includes most of the amendments which have occurred in the recent past and are likely to occur in the immediate future.

The UI provisions simulated may be either actual amendments scheduled for implementation, or they may be hypothetical provisions being studied for possible legislation. In the latter case the model becomes an analytic tool for studying policy alternatives. Five alternative provisions are compared with the present provisions to see how UI outcomes will respond. The benefit levels of each resultant system are compared; these are useful for consideration of benefit fund adequacy. The number of benefit exhaustions of alternative systems are compared as well. It is found, for instance, that the most powerful way of reducing benefit exhaustions is not simply to increase the maximum benefit period. Two alternative provisions are specified which accomplish this goal more effectively.

8.5 Further Refinements of the Model

There remain two major components which would add greatly to the usefulness of this model. The first of these is an objective function. The goals of the UI program have been repeated often* since its inception in 1935, but the goals are still conflicting and unquantified. Thus even though the present model may give accurate forecasts of the outcomes of various policies it is difficult to choose between the policies without a more precise way to balance competing goals.

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*See Blaustein (1968) for a lucid account.

The second of these is an integrated treatment of the work incentive issue. The present study has shown how estimates of continuation rates can be instrumental in showing the nature and magnitude of the incentive problem caused by UI. Some effort has been made to determine the incentive effect of different maximum benefit durations; however this is only the beginning of a complete diagnosis of the incentive effects of alternative UI provisions. Equations could be added to the model to forecast continuation rates resulting from different UI provisions and different labor market conditions. The resulting loss of labor services could then become an important argument in the objective function specified for UI systems. This would allow simultaneous consideration of the incentive effect and the income stabilization effect of a policy.

A UI model of these dimensions could play a very useful role in rationalizing policy with respect to UI. The system has changed drastically since its inception nearly forty years ago. Now is the time to spell out clearly the workings and goals of the UI system. It is hoped that this UI model will provide a useful beginning in that analysis.

APPENDIX A

THE CONDITIONAL PROBABILITY OF EXHAUSTING UI BENEFITS

Consider a group of UI claimants who made their initial claims in week t-i. Of the people still receiving UI in week t-1, what fraction will exhaust payments in week t? In order for them to exhaust payments, two conditions must apply to them:

1) They do not get a job in week t. The probability of this outcome is the continuation rate, r_{ti}.

2) They have a determination of i weeks. The fraction of initial claimants having this particular determination is X_i (section 3.6). In week t only UI claimants with determinations of i weeks or greater are still receiving payments. The number of such people is

$$\sum_{k=1}^{K} X_k = \delta_{i-1} \qquad \text{(A.1)}$$

So the fraction of people still receiving payments in week i-1 and who have a determination of i weeks is X_i/δ_{i-1}.

The above two events are independent, so the probability that both events will occur simultaneously is the product of their probabilities:

$$e_{ti} = \frac{r_{ti}\, X_i}{\delta_{i-1}} \qquad \text{(A.2)}$$

APPENDIX B

THE EQUIVALANCE OF THE MARKOV PROCESS AND THE INSURED UNEMPLOYMENT EQUATION:

This discussion will begin with equation (3.25) of Chapter III. The first element of the column vector X_{ti} is the number of people in the IU state. The number of people in that state with 0 weeks of claims is the number of initial claims in that week. The first equation is therefore

$$IU_{ti} = \left[\prod_{m=0}^{i} \left(r_{ti} - e_{ti}\right)\right] I_{t-i}. \tag{B.1}$$

The factor in brackets is the i-step transition probability, substituting from the 1-step transition matrix (3.23). The task of this appendix is to prove the proposition that the above equation is the same as equation (3.20) and therefore that

$$\left[\prod_{m=0}^{i} \left(r_{ti} - e_{ti}\right)\right] I_{t-i} = \delta_i b_{ti} I_{t-i} = IU_{ti} \tag{B.2}$$

The proof will employ mathematical induction. It has two parts:

1) Prove the proposition is true for $IU_{t-i,0}$: The equation states

$$IU_{t-i,0} = \left(r_{t-i,0} - e_{t-i,0}\right) I_{t-i} = \delta_0 b_{t-i,0}\, I_{t-i} \tag{B.3}$$

Substituting

$$r_{t-i,0} = 1,\ e_{t-i,0} = 0,\ \delta_0 = 1 \text{ and } b_{t-i,0} = r_{t-i,0} = 1,$$

both equations reduce to the indentity:

$$IU_{t-i,0} = I_{t-i} \tag{B.4}$$

2) Prove that if the proposition is true for $IU_{t-1,i-1}$ then it is also true for IU_{ti}:

$$\text{Assume } IU_{t-i,i-1} = \delta_{i-1}\, b_{t-1,i-1}\, I_{t-1}. \tag{B.5}$$

$$\text{Then } IU_{ti} = \left(r_{ti} - e_{ti}\right)\left(\delta_{i-1}\, b_{t-1,i-1}\, I_{t-i}\right), \tag{B.6}$$

where $\left(r_{ti} - e_{ti}\right)$ is the 1-step transition probability at time t.

Substituting $e_{ti} = \dfrac{\chi_i\, r_{ti}}{\delta_{i-1}}$ from Appendix A into (B.6),

$$IU_{ti} = \left(r_{ti} - \frac{\chi_i\, r_{ti}}{\delta_{i-1}}\right)\delta_{i-1}\, b_{t-1,i-1}\, I_{t-i}\ . \tag{B.7}$$

$$\text{Using } \delta_{i-1} - \chi_i = \delta_i \text{ and } b_{ti} = r_{ti}\, b_{t-1,i-1}\ , \tag{B.8}$$

$$IU_{ti} = \delta_i\, b_{ti}\, I_{t-i}. \qquad \text{Q.E.D.} \tag{B.9}$$

$$\text{Summing over } i,\ IU_t = \sum_{i=0}^{K} IU_{ti} = \sum_{i=0}^{K} \delta_i\, b_{ti}\, I_{t-i}. \tag{B.10}$$

This last equation is the insured unemployment equation, showing how it can be derived from an extended Markov process.

APPENDIX C

THE PROPERTIES OF THE DISTURBANCE TERM OF THE INSURED UNEMPLOYMENT EQUATION

b_{ti} is the only random variable in the insured unemployment equation (3.20). It is a random variable because it is a function of the vector r, which is a function of the random vector $\underline{\varepsilon}$.

$$b_{ti} = \prod_{m=0}^{i} \left(\bar{r}_{t-m,i-m} + \varepsilon_{t-m} \right) \qquad (C.1)$$

Let $\bar{b}_{t-i}$ be the non-random part of b_{ti} and $\tilde{b}_{ti}$ be the random part of b_{ti}.

$$\text{Then } b_{ti} = \bar{b}_{ti} + \tilde{b}_{ti} \qquad (C.2)$$

$$\text{where } \bar{b}_{ti} = \prod_{m=0}^{i} \bar{r}_{t-m,i-m} \qquad (C.3)$$

and, carrying out the product in (C.1),

$$\begin{aligned} \tilde{b}_{ti} = {} & \bar{r}_{ti}\, \bar{r}_{t-1,i-1}\, \varepsilon_{t-2} \cdots + \bar{r}_{ti}\, \varepsilon_{t-1}\, \bar{r}_{t-2,i-2} \cdots \\ & + \bar{r}_{ti}\, \varepsilon_{t-1}\, \varepsilon_{t-2} \cdots + \varepsilon_{t}\, \bar{r}_{t-1,i-1}\, \bar{r}_{t-2,i-2} \cdots + \cdots \\ & + \varepsilon_{t}\, \varepsilon_{t-1}\, \varepsilon_{t-2} \cdots \varepsilon_{t-26} \end{aligned} \qquad (C.4)$$

$E(\tilde{b}_{ti}) = 0$ because $\underline{\varepsilon}$ is not autocorrelated and

and $E(\varepsilon_t) = 0$.

Substituting (C.2) into the insured unemployment equation,

$$IU_t = \sum_{i=0}^{K} \delta_i \left(\bar{b}_{ti} + \tilde{b}_{ti}\right) I_{t-i} \qquad (C.5)$$

$$IU_t = \sum_{i=0}^{K} \delta_i \, \bar{b}_{ti} \, I_{t-1} + U_t \, , \qquad (C.6)$$

where $U_t = \sum_{i=0}^{K} \delta_i \, \tilde{b}_{ti} \, I_{t-1}$ (C.7)

is the disturbance term of the insured unemployment equation.

$$E\left(U_t\right) = \sum_{i=0}^{K} \delta_i \, E\left(\tilde{b}_{ti}\right) I_{t-1} = 0 \, . \qquad (C.8)$$

Let p represent the number of weeks of lag in the autocorrelation function of the disturbance term. Then the autocovariance function of the insured unemployment equation is given by

$$E\left(U_t \, U_{t-p}\right) = E\left\{\sum_{i=0}^{K} \delta_i \, \tilde{b}_{ti} \, I_{t-i}\right\}\left\{\sum_{j=0}^{K} \delta_i \, \tilde{b}_{t-p,j} \, I_{t-j-p}\right\} \qquad (C.9)$$

$$E\left(U_t \, U_{t-p}\right) = \sum_{i=0}^{K} \sum_{j=0}^{K} \delta_i \, \delta_j \, E\left(\tilde{b}_{ti} \, \tilde{b}_{t-p,j}\right) I_{t-i} \, I_{t-j-p} \qquad (C.10)$$

Now $\tilde{b}_{ti} = \sum_{n=0}^{i} \left(\prod_{\substack{m=0 \\ m \neq n}}^{i} \bar{r}_{t-m,i-m}\right) \varepsilon_{t-n}$ + cross terms. (C.11)

Likewise $\tilde{b}_{t-p,j} = \sum_{n=0}^{j} \left(\prod_{\substack{m=0 \\ m \neq n}}^{j} \bar{r}_{t-p-m,j-m}\right) \varepsilon_{t-p-n}$ + cross terms, (C.12)

so $\tilde{b}_{ti} \, \tilde{b}_{t-p,j} = \sum_{n=p}^{i} \left(\prod_{\substack{m=0 \\ m \neq n}}^{i} \bar{r}_{t-m,i-m}\right)\left(\prod_{\substack{m=0 \\ m \neq n}}^{j} \bar{r}_{t-p-m,j-m}\right) \varepsilon^{2}_{t-n}$

+ cross terms. (C.13)

Defining $\sigma^2 = E(\varepsilon_t^2)$, (C.14)

$$E\left(\tilde{b}_{ti}\ \tilde{b}_{t-p,j}\right) = \sigma^2 \sum_{n=p}^{i} \left(\prod_{\substack{m=0\\ m\neq n}}^{i} \bar{r}_{t-m,i-m}\right)\left(\prod_{\substack{m=0\\ m\neq n}}^{i} \bar{r}_{t-p-m,j-m}\right) \qquad \text{(C.15)}$$

therefore $$E\left(\tilde{b}_{ti}\ \tilde{b}_{t-p,j}\right) = \left\{\begin{array}{l} 0 \text{ for } p > i \\ >0 \text{ for } 0 \leq p \leq i \end{array}\right\}. \qquad \text{(C.16)}$$

Since all of the terms in the sum in (C.15) are positive, the larger the lag p, the smaller the autocovariance of the disturbance U.

Returning to equation (C.10) and combining it with the information from (C.16) we can reach two conclusions:

1) The disturbance is heteroscedastic. Equation (C.10) gives the variance of the disturbance when $p = 0$. It varies roughly with the square of the variable I_t (initial claims).

2) The disturbance is autocorrelated. The autocorrelation is positive for lags of 1 week through K weeks and declines as the length of the lag increases. For lags greater than K the autocorrelation is zero.

It is not surprising that autocorrelation of the continued claims disturbances exists, since a random error in a continuation rate in one week will carry over into later weeks. For example, suppose an exogenous shock raises the continuation rate in week t, resulting in more than the expected number of continued claims in that week. Some of these additional claimants will continue to make claims in week t+1 even if the continuation rate drops back to its expected value. Therefore the high continuation rate in week t leads to high continued claims in both week t and week t+1 (and weeks t+2 through t+K). The continued claims disturbances will be all positive from week t through week t+k. In general this "overflow" effect will cause the residuals to be highly positively correlated.

APPENDIX D

A TRANSFORMATION TO IMPROVE THE EFFICIENCY OF THE ESTIMATION BY REDUCING AUTOCORRELATION OF THE DISTURBANCE TERM

Appendix C shows that the disturbance term U_t is autocorrelated of degree K. This is verified in the actual estimations by the finding that the residuals from the first fitting are very highly correlated.

We assume the residuals are a K-th order Markov process:

$$U_t = \sum_{m=1}^{K} d_m U_{t-m} + U_t^* . \qquad (D.1)$$

The $\{d_m\}$ are assumed to be approximately constant (but unknown) autocorrelation parameters. The term U_t^* is assumed to be an unautocorrelated disturbance term. Thus we have two disturbance terms: U_t, which is autocorrelated and U_t^* which is not autocorrelated. We now transform the equation so that the disturbance term is U_t^* rather than U_t.

Write the model of Insured Unemployment as

$IU_t = \overline{IU}_t(\underline{a}) + U_t$, where $\overline{IU}$ is the non-linear function of the parameter vector $\underline{a}$ in equation (3.20). Then

$$IU_t = \overline{IU}_t(\underline{a}) + \sum_{m=1}^{K} d_m U_{t-m} + U_t^* . \qquad (D.2)$$

Substituting the definition of the autocorrelated residuals,

$$U_{t-m} = IU_{t-m} - \overline{IU}_{t-m}(\underline{a}) \ , \qquad (D.3)$$

gives
$$IU_t = \overline{IU}_t(\underline{a}) + \sum_{m=1}^{K} d_m \left\{ IU_{t-m} - \overline{IU}_{t-m}(\underline{a}) \right\} + U_t^* \qquad (D.4)$$

or
$$IU_t = F_t(\underline{d},\underline{a}) + U_t^* \qquad (D.5)$$

This last equation expresses IU_t as the sum of a new non-linear function of the two vectors of parameters $\underline{a}$ and $\underline{d}$ and the unautocorrelated error term, U_t^*. This equation is used directly to estimate the parameters $\underline{a}$ and $\underline{d}$ by choosing parameters $\hat{\underline{d}}$ and $\hat{\underline{a}}$ which minimize the sum of the squares of the residuals defined by

$$\hat{U}_t = IU_t - F_t(\hat{\underline{d}},\hat{\underline{a}}) \ . \qquad (D.6)$$

The minimization is performed subject to the constraint that the sum of the error terms $\hat{U}_t$ be approximately zero. This is necessary because the estimation minimizes the sum of squares of U_t^* rather than $\hat{U}_t$, creating the possibility that the residuals $\hat{U}_t$ will not be centered about zero even though

$$E\,(U_t^*) = 0. \qquad (D.7)$$

The restriction is imposed by expressing the residuals U_t in equation (D.1) as deviations from their mean, $\overline{U}$. The error specification is rewritten

$$U_t = \sum_{m=1}^{K} d_m (U_{t-m} - \overline{U}) + U_t^*. \qquad (D.8)$$

To see the implications of this specification it is only necessary to sum U_t from the above equation over all t.

$$\sum_t U_t = \sum_{m=1}^{K} d_m \left(\sum_t U_{t-m} - \sum_t \overline{U}\right) + \Sigma U_t^* \qquad (D.9)$$

The first term on the right-hand side is approximately zero, leaving

$$\sum_t U_t \cong \sum_t U_t^* \qquad (D.10)$$

The estimated residuals $\hat{U}_t$ bear an equivalent relationship to the estimated residuals $\hat{U}_t^*$.

$$\sum_t \hat{U}_t \cong \sum_t \hat{U}_t^* \qquad (D.11)$$

The quantity $\sum_t \hat{U}_t^*$ will be exactly zero only if there is a constant term in the function F_t. Since there is no such constant term the quantity $\sum_t U_t^*$ will not necessarily be exactly zero, but it will be very small compared to the absolute size of the residuals $\hat{U}_t^*$ or $\hat{U}_t$.[*] For the purposes of this estimation,

$$\sum_t \hat{U}_t \cong 0 \,. \qquad (D.12)$$

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[*] The least-squares method minimizes the sum of squares, $\sum_t \hat{U}_t^*$. This will require that the residuals be approximately centered about zero, with about half of the residuals positive and half negative. Thus the sum $\sum_t \hat{U}_t^*$ will be near zero.

Therefore the mean $\overline{U}_t$ will also be approximately zero and specification (D.8) will be identical to (D.1). The practical effect of specification (D.8) is therefore to impose the constraint that the sum of the error terms U_t be very small but otherwise not to influence the estimation.

It is easy to show that this method is equivalent to the Hildreth-Liu method if the original function is linear and is the same as partial differencing the original variables in the case where the original function is linear and the autocorrelation parameters are known. The current method merely generalizes the philosophy behind those methods to the case of non-linear functions. It is often desirable to make allowance for autocorrelation of residuals in applications of least-squares methods to time series data, whether the functions estimated are linear or nonlinear.

APPENDIX E

RESOLVING THE DIFFERENCES BETWEEN A WEEKLY MODEL AND MONTHLY DATA

1) The continuation rates are a function of the number of weeks since the workers made initial claims. In the weekly model that concept is well-defined since a worker making his i-th weekly continued claim has been unemployed i weeks. In the monthly model a person in his second month of claims may have been unemployed between 1 and 8 weeks depending upon whether he made his initial claim in the beginning or end of the first month and whether he made his continued claim in the beginning or end of the second month. It is therefore necessary to establish a reference point in each month at which point all claims are assumed to occur. Each reference point will be defined by its time in weeks since initial claim. The durations are calculated as the average time which has elapsed since initial claim for all workers making continued claims during that month. Considering a single cohort of workers who made their initial claim in month 0, the duration of insured unemployment is tabulated in column 2 of Table E.1. The coefficients δ_i, which represent the fraction of initial claimants who have not yet exhausted their benefits, are calculated using

equation (3.19), and the duration of unemployment at the reference point in each month. These are tabulated in column 3.

2) The coefficients b_{ti} (the fraction of initial claimants still unemployed after i weeks of payments) can no longer be calculated as the simple product of the continuation rates. If a continuation rate persists for $(d_i - d_{i-1})$ weeks, as we assume in the monthly model, the continuation rate for the i-th month is $r_i \, (d_i - d_{i-1})$, where d_i = the number of weeks of unemployment at the reference point for the i-th month. The coefficients b_{ti} can be calculated from

$$b_{ti} = \prod_{m=0}^{i} r_{t-m,i-m} \, (d_m - d_{m-1}) \qquad \text{(E.1)}$$

3) A UI recipient can make a claim for each week he is unemployed, totaling about 4 claims per month, even though he can only make 1 initial claim in month 0. Therefore a factor (W_i) must be included in the insured unemployment equation to represent the number of claims which will be made in month i if all continuation rates are equal to one. The factors are tabulated in column 3.

The actual equation used to forecast insured unemployment from monthly data is

$$IU_t = \sum_{i=0}^{K} W_i \, \delta_i \, b_{ti} \, F_{t-i} \qquad \text{(E.2)}$$

The equation can be derived formally by summing the weekly equation in the time domain under the assumptions of constant δ_i and b_{ti} over the length of one month.

4) Similar factors can be derived for the exhaustions equation. They appear in columns 5 through 7. The only difference is that payments (including final payments, which are used to count exhaustions) are recorded about a week later than are claims.

5) This careful adjustment of the model is justified because it preserves the identity of the continuation rates between weekly and monthly models. Without these considerations it would be necessary to define separate weekly and monthly continuation rates, destroying the coherence of the concept.

TABLE E.1

COEFFICIENTS USED TO AGGREGATE WEEKLY TO MONTHLY MODEL

	Insured unemployment equation			Exhaustions equation		
1	2	3	4	5	6	7
Month (i)	Average duration of unemployment assuming I in month 0 (d_i)	Fraction of initial claimants who have not exhausted (δ_i)	Weekly claims per month (W_i)	Average duration (d_i)	Fraction of initial claimants who exhaust in month i (X_i)	Weekly payments per month (W_i)
0	1.075	1.0	2.68	1.43	0.	.810
1	4.33	1.0	4.33	3.44	0.	4.33
2	8.66	1.0	4.33	8.00	.00233	4.33
3	12.9	.929	4.33	12.3	.0303	4.33
4	17.2	.769	4.33	16.6	.0372	4.33
5	21.5	.572	4.33	21.0	.0372	4.33
6	25.	.478	2.68	24.5	.131	3.494
7*		0	0	26.0	.441	0.25

*A UI recipient would make his 26th (and final) claim in the last week of month 6 if he made his initial claim in the last week of month 0. Thus there can be no claims in month 7. However, because of the (approximately one week) lag in recording payments a final payment may be recorded in the first week of month 7.

APPENDIX F

MEASURING INSURED UNEMPLOYMENT

Minor inconsistencies created by the complexity of the Michigan UI system and the method of data collection are easily resolved by proper data transformation.

1) In administrative data continued claims are recorded during the week in which they were filed. However they cover insured unemployment of the preceding week because claimants must file after completion of a week of insured unemployment. Therefore insured unemployment in week t is equal to the number of continued claims in week t+1, not t.

2) Some jurisdictions take claims on a bi-weekly basis: either "two weeks compensable" (TWC), or "waiting week and first compensable" (WFC). Each of these bi-weekly claims represents two weeks of insured unemployment, rather than one week. Since separate data is collected for each of these types of data, a simple transformation gives the number of waiting week insured unemployment (WIU) and compensable insured unemployment (CIU) in week t:

$$WIU_t = TW_{t+1} - WFC_{t+1} - WFC_{t+2} \qquad (F.1)$$

$$CIU_t = TC_{t+1} - TWC_{t+1} - TWC_{t+2} \qquad (F.2)$$

where TW_t is the total number of waiting weeks claimed in week t and TC_t is the total number of compensable weeks claimed in week t.

3) Weeks of unemployment are insured whether they are waiting weeks or compensable. Therefore insured unemployment is defined as:

$$IU_t = WIU_t + CIU_t \tag{F.3}$$

4) These transformations are applied to weekly data before they are aggregated to monthly data. The monthly aggregation is performed by adding all of the claims for weeks wholly within a month plus a fraction of the claims taken in weeks included within two months. The fraction is equal to the number of days of the week within the particular month.

APPENDIX G

ESTIMATING THE STANDARD ERRORS OF THE LEAST SQUARES PARAMETERS

A first-order Taylor series approximation of IU is used to estimate both the parameters and standard errors of the parameters (Draper and Smith, 1966, p. 267). Dropping all second-order and higher terms we approximate IU by

$$IU \cong IU(X;\hat{a}) + \sum_{i=1}^{p} \left.\frac{\partial IU}{\partial a_i}\right|_{a=\hat{a}} (a_i - \hat{a}_i) + U$$

If we set

$$Z_i = \left.\frac{\partial IU}{\partial a_i}\right|_{a=\hat{a}}$$

the model takes the linear form,

$$IU - IU\ (X;a) = \sum_{i=1}^{p} Z_i(a-\hat{a}) + U$$

Applying linear least squares theory

$$\text{Var } \hat{a} = s^2(Z'Z)^{-1}$$

where s^2 is estimated as the sum of squared errors divided by n-p.

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